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QRP Quarterly

Volume 44 Number 2
Spring 2003
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Journal of the QRP Amateur Radio Club International

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- Contest Results—Running of the Bulls Fall QSO Party Top Band Sprint

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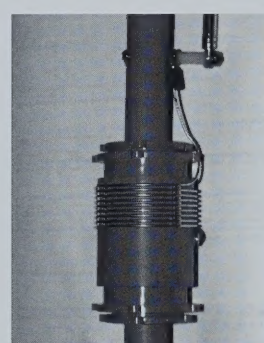

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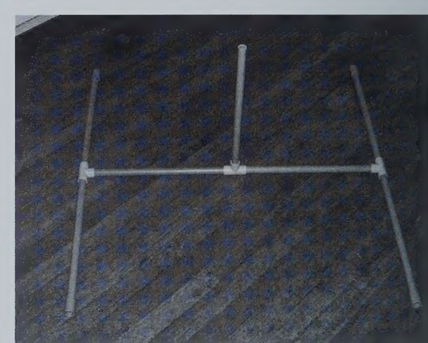

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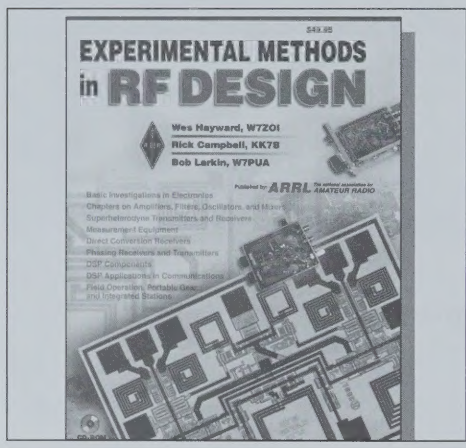

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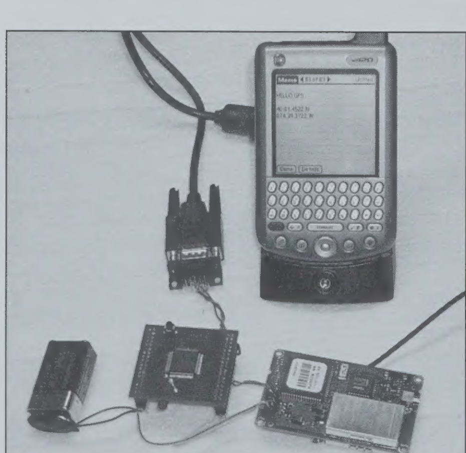

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From the Editor's Desk

Mike Boatright, KO4WX—Editor ko4wx@mindspring.com

There is nowhere on the planet prettier than Atlanta, Georgia in the springtime. What does that have to do with QRP? Well, for one thing, your new *QRP Quarterly* editor happens to live there (and, frankly, he is very biased about where he experiences springtime!). For another, it means that with spring here, FDIM is just around the corner. Add to that a new season of outdoor operating contests (for those that do not go for freezing their buns off) and a whole new slate of trail-friendly radios to go with them, and you cannot help but be happy!

New editor, you say? Well, all good things must change, I guess. I am humbled to walk in the footsteps of all of the wonderful editors that have made this the premier journal of QRP operating, construction, and just plain fun!

There are other changes coming along, but I will leave those to Joe Spencer, KK5NA to announce. It is all for the better, folks—I promise.

My personal goal as editor of *QRP Quarterly* is to see it become the premier *international* journal of QRP operating, construction, and fun. International? Wait a minute, is it not already an international magazine? Well, yes, it is. But I have personally done a fair amount of international travel, and I know that there is a lot going on out there that many stateside hams never get the opportunity to experience.

As we go to press with this issue, many of us are glued to our televisions to see the latest up-to-the-minute news on battles in the Middle East. Now, I am not here to debate the pros and cons of any of that, no sir. But it does bring to my mind that it is the international camaraderie of our QRP gang (and other amateurs that enjoy the hobby as much as we seem to) that seems to transcend all politics, religions and wars. There is no Q-signal for "are you pro or con?" nor for "are you with us or against us?"

It would be terribly presumptuous to think that QRP ARCI could or would ever have direct impact on the events in the world, but I personally believe that anything that spreads international goodwill and friendship like our group does certainly cannot hurt. With that in mind, I am going to jump in feet first as your new editor and issue you, the membership of QRP ARCI, a challenge that in the next issue of *QRP Quarterly* we have at least one new regular column (you pick the topic) and at least four articles from international authors. Are you up for the challenge?

On a personal note, many of you may have at one time met—or heard me talk about—a wonderful old Gordon Setter named Daphnne. I once operated a slow speed Fox and Hounds hunt under her name. She was the best dog that a QRP operator could have ever asked for. With heavy hearts we had to put her down in the midst of putting together this issue of the *QRP Quarterly*. In my life, I have never had a more loyal, loving canine friend, and so—as your new editor—I dedicate this issue to her and to the many others like her who have brought joy to QRP operators everywhere.

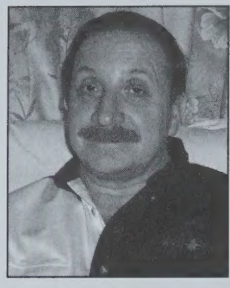
—72 de Mike, KO4WX

On the Cover

It's springtime and those of us who don't work on antennas in the dead of winter will soon be busy stringing up new wires. How about a new antenna tuner for that dipole, loop or box-spring? Our cover photo is the inside of a Differential-T Antenna Tuner built by Mike Branca, W3IRZ. While there are some pretty good commercial differential-Ts on the market, homebrew is certainly within the reach of most hams. Check out Mike's article on page 28 for the details. *—Mike, KO4WX*

From the President

Joe Spencer—KK5NA kk5na@quadj.com



Hello again! The QRP ARCI is still growing and still producing one of the finest magazines in the hobby of amateur radio (of course, I think it is the best one!) Since the last issue, we have unfortunately lost our editor Mike Goins, WB5YJX. Mike has our sincere thanks for a great job during his time as editor and for the innovations he brought to the *QQ* and to the club in general. Our new editor is a familiar QRPer, Mike Boatright, KO4WX, who has stepped up to help us in our transition to a new process of publishing, subscription management, ads and marketing. *QRP Quarterly* will remain the fine magazine it has been with the help of our dedicated volunteer staff, and as we continue to receive the excellent quality of material that goes into it.

This year, we are going to be increasing dues for club membership and *QQ* subscription. Beginning July 1, 2003 the rates will be $18 per year for members in the US, US$21 per year for members in Canada, and US$23 per year for all others. The increase will effect all renewals beginning July 1, 2003, so now is the time to renew...and the two-year subscription will save you more money. .

It has been a long time since the last dues increase and the time has come to meet the increased costs of doing business and maintaining consistent high quality in *QRP Quarterly*.

Wow, this has been a fun winter for operating! A great Fox Hunt on 40 meters each week, combined with a Truffle each time (the Flying Pigs contest). A really fun Pesky Texan Armadillo Hunt, good DX and Sprints almost every other week!

This is also an exciting time of the year as the many great QRP Hamfest activities finally start back up! Try to make as many as you can. The ones coming to my mind to catch in the next few months are:

- Arkiecon—1st Friday/Saturday in April; this is one of the best QRP gatherings in the country!
- Atlanticon—Always an exciting time!
- Dayton FDIM—Try to make the trip to Dayton for another great Four Days in May event!
- HAMCOM—3rd weekend of June in Arlington Texas. A big QRP Event is planned this year, featuring George Dobbs, Grahm Firth, Tony Fishpool, Dr. Megacycle and Doug Hendriks.

Help Wanted

QRP ARCI is looking for some new officers/managers to make the day-to-day business happen. We are looking for:

- Net Manager—this position has been idle and needs reborn...!
- Contest Manager—Randy, K7TQ, has done a fabulous job but is ready to step down due to other commitments
- Certificate Manager—work with the Contest Manager in preparing, printing and distributing certificates for the club's contests.

Until next time...keep promoting QRP!

—72, Joe KK5NA

Announcements

A Reminder—Plan to Attend FDIM!

This year's *all day* seminar on Thursday, May 15 will feature world renowned QRPers. Activities will begin at 8:00 a.m. in the large ballroom at the Ramada Inn. Lunch will be "on your own" but since it is Thursday, the restaurants are not full and there are many nearby. There will be a one and a half-hour lunch period to socialize and not be rushed.

Here is the speaker current line up and schedule:

08:15 a.m.—Rex Harper, W1REX & Darell Brehm, "Quartz Crystals and Their Implementations in QRP Circuits"
09:05 a.m.—Stephen E. Brown, W9HC, "Restoring and Installing a Multi-Band Trap Vertical for a QRP Field Day"
09:55 a.m.—Break
10:25 a.m.—George Dobbs, G3RJV, "Yet More Minimalist Radio Philosophy and Practical...a G3RJV ramble through one-night and weekend projects for the home-brewer"
11:15 a.m.—End of morning session remarks
11:25 a.m.—Lunch on your own
1:00 p.m.—Peter Zenker, DL2FI, "News of German QRP"
1:50 p.m.—John Cumming, VE3JC, "Making Waves—A QRP Celebration of Spectrum Analysis"
2:40 p.m.—Break
3:10 p.m.—Jim Kortge, K8IQY, "The K8IQY 2N2/30 Transceiver"
4:00 p.m.—Mike Bryce, WB8VGE, "Radio Repair 101"

A number of goodies will be provided as part of your seminar registration fee including a copy of the Proceedings. Other surprises will be well worth the price of admission.

Buildathon 2003

The Flying Pigs Amateur Radio Club International and the North Georgia QRP Club will again host a "Buildathon" at FDIM 2003. Last year, these two clubs combined their resources to help 35 first time builders construct and calibrate a NOGA Watt Meter. Feedback on the Buildathon was extremely positive, with many requests for a repeat event.

The Buildathon will be held on Thursday, May 15, 2003 from 5 p.m. EDT to approximately 8 p.m. EDT.

Test Equipment Clinic

The Flying Pigs QRP Club International will host a free Test Equipment Clinic on Thursday, May 15,

2003, from 7:30 p.m. to 11 p.m. The Pigs will have all types of test equipment set up and ready to use. Elmering will be provided by both the Flying Pigs and NOGA. If you are interested in learning on how to use a VOM, an Oscilloscope, or a Spectrum Analyzer, please stop in. If you have something you have built and just can't seem to get working, please bring it with you (along with schematic) and we'll try to help you to get it working.

Club/Vendor Night

On Friday night (and on other nights optionally), clubs and vendors will be set up in the Main ballroom. 15 to 20 vendors will be at this event. Clubs are encouraged to set up a table to promote their club. Anyone desiring a table for this event, which runs from 7:30 to 11 p.m. Friday, should advise Bill Phillips, AD6JV (bill1048@direcway.com). If you are a vendor or a club and wish to set up at a table on other nights, that's fine too. Just find a table and pitch your tent.

Saturday Evening Banquet

The QRP Recognition banquet will be held on Saturday night this year, beginning at 7 p.m. This is a full course meal and the price is $25.00. The highlight of the banquet will be the induction of new members into the QRP ARCI Hall of Fame. You can count on the usual door prizes, too.

Design/Building Contest

FDIM 2003 will have the traditional contests with a separate category for both homebrew and kits. As has been done in the past, these two categories are wide open. Use your imagination and bring your latest homebrew project, kit (with mods of course), and antennas, whatever! Judges will select winners for prizes in each of the two areas.

Winners will have an article spot in *QRP Quarterly*. Please note—entries to the contests must be delivered to the judging area no late than 8 p.m. Friday night.

SMT Challenge

The special focus category for FDIM 2003 in the design/build it contests is SMT. SMT is becoming a way of life and as builders, we will need to work with it. This year, we ask that you bring your latest SMT project and any construction aids that you have to help with SMT construction. This category is open to functioning radios, tuners, test equipment and SMT construction aids. The only rule is that at least 25% of the electronic components used are SMT. There will be awards for both projects and aids. So get out your tweezers and magnifying glasses and bring the results to FDIM 2003.

Hospitality

Every night there will be two large ballrooms provided by QRP ARCI, simply as gathering places for having fun!

More details and registration information can be found on the QRP ARCI web site, www.qrparci.org.

New Members this Quarter

11356	AA6GF	Daniel Mahoney
11357	KB1ZN	Philip Brown
11358	K8AA	David Larson
11359	M4GNS	Gary Scott
11360	WB6IXS	Eleno Sandoval
11361	AB1AV	William Noyce
11362	W2GIW	Kenneth Jones
11363	N3BYY	William Howell
11364	KB9ZUV	Gary Lee
11365	NU6P	John Glass
11366	K5XU	Mike Duke
11367	WA3CAO	Anthony McCloskey
11368	KM5CW	Joe Martin
11369	W3FML	Fred Leader
11370	KC5HAC	James Rue
11371	WN2DX	Martin K. Szumera
11372	K4AEN	Thomas Morehouse
11373	KD5JTU	Richard J. Tilgner
11374	WD5JFR	Henry Kolesnik
11375	N8CTI	Steve Williams
11376	KG4SUN	Walter King
11377	W7KXB	William Harris
11378	KP4AZ	Dr. Antoni Llona
11379	K5OT	Larry Hammel
11380	NFØG	Brian Broekema
11381	K3PH	Robert A. Schreibmaier
11382	WA7DFD	Allan Buckley
11383	KCØOOU	Mark Thomas
11384	KQ4TQ	Timothy Glennon
11385	WBØMBI	Jerry Abrams
11386	W7JHS	Cormac Thompson
11387	W5URP	Virgil S. Hinson
11388	K4AAR	Philip Kurman
11389	K7SBK	Al Gerbens
11390	KA5SQJ	Ronald Hill
11391	K9TJL	T. J. Liddell
11392	KO4PH	Douglas Wise
11393	KA9HIJ	Jeffery B. Neal
11394	N3KPX	Rodney Watson
11395	VE2OEW	Pierre Vallee
11396	AG4QZ	Maury Cupitt
11397	N3HKN	Richard Boley
11398	KG6IIP	Randel Livingood
11399		Walter Conklin Jr
11400		Daniel C. Newcome
11401	KD8SY	Harold Pressman
11402	KC7VHS	Perry Steinman
11403	W9JBE	Richard Wood
11404	WØSCB	Sean Bohannan
11405	K3VOT	Robert C. Aurand
11406	N5RMJ	Mark Jones
11407	WB8YYY	Curt Milton
11408	NQ4Q	John Willmuth
11409	KE7VZ	Harry A. Searles
11410	N2YNL	Michael Sajdak
11411	WBØGKH	Mitchel Schultz
11412	K6QKL	Chuck Hines
11413	K1YCM	Lester Veenstra
11414	KD7SRC	Greg Storms
11415	WB4YJT	John Ventenna
11416	K8FFO	Francis Morgan
11417	W4RPR	Raymond Richard
11418	KF4TAP	Brian Ford
11419	KA1KNE	William Cook
11420	K4CSO	Charles Osborne
11421	N7ZO	Robert Wright
11422	N9LTV	Rod Sievers
11423	ABØXE	Stephen Howard
11424	VE3KRP	Ed Kucbel
11425	VE2TTA	Francois Proulx
11426	N8UU	Russell Beutler
11427	AC4CX	Don Lloyd
11428	KD8YT	Don Ratta
11429	KØOPR	Stan Cooper
11430	K7JIM	James Hassler
11431	SMØJZT	Tilman Thulesius
11432	KD5RVX	John Moore
11433	NY2LJ	Lonnie Juli
11434	K2EKM	William Gregory
11435	K7NWS	Boeing Employees ARS
11436	K2UY	Kenneth Wynne
11437	N9YVU	Scott Hengert
11438	K9PLX	E. Charles Hopper
11439	N1ILD	Gerald Mullen
11440	WB5OFD	Laurence Baker
11441	WA3PCS	Andrew Yakubik
11442	W4WYD	Barry Sandefer
11443	TF3KX	Kristinn Andersen
11444	AF9W	Robert Stephens
11445	AG4XX	Felix Sawicki
11446	KBØVCC	Dale Anderson
11447	W7UAS	Eldon Bickley
11448	WB5EKU	Donald Jacob
11449	AC7LU	Charley Scarborough
11450	VK4BAZ	Barry Travers

Idea Exchange
Technical Tidbits for the QRPer

Mike Czuhajewski—WA8MCQ wa8mcq@comcast.net

IN THIS EDITION OF THE IDEA EXCHANGE:

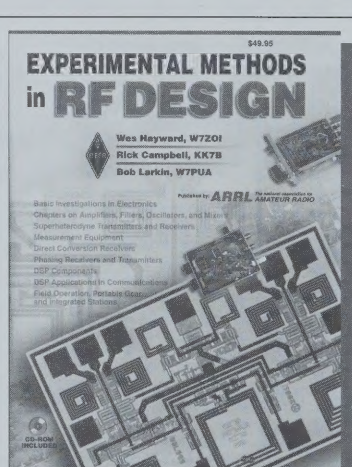
It's Safe to Go Back to QRP-L

QRP-L is the QRP Internet mail reflector started ten years ago by Chuck Adams, K7QO (K5FO at the time). It runs several dozens of postings per day, mostly related to QRP in some way or other. Unfortunately, in the last year or two things deteriorated somewhat, with lots of sniping, personal attacks, flame wars, etc creeping in from time to time. This caused a number of people to unsubscribe.

Jim Eshleman, N3VXI, is a system administrator at Lehigh University in Pennsylvania, which hosts QRP-L on their system. Early this year he put the list into "moderated" mode for an indefinite period, meaning that no posts appear until he approves them. Although this can result in some delay before posts are sent out, it does have a major benefit-the attacks, flame wars, etc have dropped to zero and QRP-L is once again a nice, calm QRP discussion list with a high signal to noise ratio. (Details on signing up can be found in "QRP Online" at the end of the column.)

If you unsubscribed to QRP-L because of these things, it's safe to come back now.

P.S.—Speaking of mail reflectors, take a look at the QRP Online section at the end of the column. I've added a new sort-of-QRP reflector, HFPack. While not really QRP oriented, it's dedicated to portable HF operation (such as bicycle mobile, backpacking, etc) and many of the discussion topics may be of interest to QRPers since some of us do the same things.



New RF Book from Hayward and Friends

A number of us knew this was in the works for quite a while, but were sworn to secrecy. I originally expected it to come out over a year ago, but it's here at last! It's expensive, it's big, it's heavy. It's great. Consider it the long awaited sequel to *Solid State Design for the Radio Amateur*, the QRPer's Bible [also known as *SSD*—ed.].

The title is *Experimental Methods in RF Design*, written by Wes Hayward, W7ZOI, Rick Campbell, KK7B, and Bob Larkin, W7PUA [affectionately known as *EMRFD*—ed.]. Although each author had inputs to all chapters, some were mainly responsible for certain ones, and "About the authors" tells which is which. (Wes has seven, the others have two each.)

There's a bit of sticker shock on this latest ARRL book (catalog #8799), at $49.95, but the sucker is plenty big. It's a paperback of over 500 pages and 1000 figures, almost 8-1/2 x 11, and a full inch thick. It's heavy enough to result in a concussion if the family cat happens to be walking by the workbench when you accidentally knock it off the edge. Divide the cost by the gazillions of hours you'll probably spend with it and it will seem more reasonable.

You can probably pick it up at hamfests at a bit of a discount; at least in my area, ARRL book dealers typically offer some discount off the cover prices. You can also order direct from ARRL, or from Bill Kelsey, N8ET of Kanga US (at http://www.bright.net/~kanga). When I checked on 5 March, they both had the same list price but the shipping rate from Kanga was several dollars less.

That "1000 figures" comes from the W7ZOI web page and at first I wasn't about to count them. But since I'm out of work for several weeks recovering from bypass surgery, things were starting to get boring so I did it after all—there are 1017 figures (including photos). It didn't really take long to count them, either, and it was a good excuse to go through the book page-by-page for a quick overview.

Like many books nowadays, this one comes with a CDROM, and this is a heck of a bonus. First, in the 'Articles' folder, there are 60 technical articles which have appeared earlier in print, mostly from *QEX* and *QST*, and it contains a huge number of my favorites over the years, going as far back as the classic W7EL Optimized QRP Transceiver in 1980. (There are a few even earlier than that.) Even if you have all those old *QST*s and *QEX*s in the house, having all these excellent homebrew arti-

cles in one place on the CD is very handy. If you don't have access to all the old magazines, getting all those additional articles on the CD is priceless.

You can't tell what they are from the file names (e.g., qex199505.pdf) but a full description of the contents of the CD starts on Page 491 in the book. For browsing the articles, your best bet is a file in the root directory of the CD called 'articles.pdf.' It's a list of all the articles, and it's hyperlinked. Just click on a title and it automatically opens it. All of the files are in the Adobe Acrobat PDF format; the free reader is included (under the Acrobat folder) in case you don't already have it.

The 'DSP' folder on the CD has a number of programs for use with Chapters 10 and 11 (Digital Signal Processing). It also contains a full set of documentation for the DSP-10 all mode 2-Meter transceiver, with the three *QST* articles plus additional info on construction, along with related software.

Finally, there's a folder named 'Software,' which contains a collection of useful routines similar to the ones that come on the disk with *Introduction to RF Design* (also by W7ZOI, still available from ARRL). I bought one of the very first copies when that book came out and all of the programs on the floppy were in DOS. They were a bit clunky but they worked, and I still use one of them to this day. The ones on the CDROM are Windows™ based and easier to work with. (The file 'Ladpac2002.txt' is the online manual for the collection of routines.)

My favorite has always been GPLA, the General Purpose Ladder Analysis program, used to run frequency sweeps on component networks such as low pass filters, crystal filters, tuned circuits, etc. The Windows based version is a lot easier to configure. It also has an added feature which allows you to draw a box on a portion of a frequency sweep display to zoom in. You could also zoom in on a smaller portion with the DOS version by reconfiguring the sweep parameters, but it was tedious.

Setting up the networks was pretty tedious under the DOS version, too. The "schematic capture" was all done in a text based file, painstakingly typed in separately using a word processor and saved to disk. The Windows version still uses the same text based format to save and read files, but now there's 'LadBuild.exe,' or Ladder Builder, which is used to build the circuit graphically on the screen. It then converts your schematic into the text based file format which you open with GPLA. After playing with it for a few minutes, I found it very easy to use and, for me, a real joy compared to the schematic entry systems on some other filter analysis software I've used.

When you first open Ladder Builder, it prompts you to click anywhere on the screen. When you do, a default schematic of 18 elements pops up, complete with signal generator at one end and load resistor at the other. Next, you quickly trim it to size by selecting elements that you don't need and clicking "Remove Part N." When you highlight a particular element, you can also change it into a capacitor, inductor, resistor, crystal or RLB (explained later) with a single click on the appropriate button. Another button changes it from a series component to one that goes to ground. Inserting additional components is just as easy. (Up to 30 elements are allowed.) When done, save the file and it's ready to be opened by GPLA.

The default schematic contains a part that looks like an upside down 'U' on the screen at component position 30, near the signal generator. Leave it in. That's a Return Loss Bridge (RLB), which is one of the available component types that can be selected. It isn't absolutely essential that you include this one on designs done from scratch, although it is required in order for the S11 sweep to be shown when using GPLA. (The sweep we're usually interested in is S21, which is the input/output response of the network, shown in red on the display. S11 is the return loss sweep, shown in blue, and not everyone will be interested in that one.)

I did note that two "components" available with the DOS version of GPLA do not appear to be supported by the Windows version or Ladder Builder. They are "series tuned circuit" (STC) and "parallel tuned circuit" (PTC). The latter is something you'd most likely encounter when trying to analyze an elliptic transmitting low pass filter, where some of the series inductors have capacitors in parallel to give additional attenuation at certain harmonic frequencies. (Page 9.40 of the book has a schematic of an audio filter using them.)

I asked Wes about this, and he indicated that it was simply a "ran out of time" issue and he intends to add them later. He was under some time pressure to get as much as possible of the software suite done and the main thing he wanted to do was have the crystal filter details in place. He gave that priority because he said his programs were some of the only ones available that did crystal ladders, and he really wanted to get Finetune (Meshtune in the DOS incarnation) and XLAD in place. He intends to add the series and parallel tuned components as time allows, and will make the updated software available through either the ARRL site or his own.

Wes asked me to mention that all of the design programs in the software suite will generate outputs that can be read by both GPLA and Ladder Builder.

When swapping e-mails with Wes, he added a little bit about the work of the other two authors. This is adapted from his comments:

"Rick [KK7B—ed.] does a lot with answering how to get a direct conversion receiver going. His work [in Chapters 8 and 9—WA8MCQ] summarizes many, many years of work with them, and adds a great deal for the person trying to build a good one. His extensions of the R2 receiver as the R2-Pro take the methods into the 21st century. And his treatment of phasing is probably the best that exists today, at any level of journal.

"Bob's [W7PUA—ed.] treatment of DSP [Chapters 10 and 11-WA8MCQ] is a real departure for those who have tried to delve into this subject. His approach to DSP is much more down to earth than is typical of this highly mathematical field. And that 17 meter transceiver [in Chapter 11—WA8MCQ] really plays nicely while being a few dB simpler than the DSP-10 transceiver."

Being the first printing, there are inevitably a few warts in the book. W7ZOI has a list of errata on his web page (at http://users.easystreet.com/w7zoi/emrfd.html). A lot of them are simple typos which are instantly obvious when you see them, although a few are a bit more substantial, such as an incorrect photo used, and a schematic missing some parts. At the time of writing, his page indicates that things will be removed from his errata list as they appear on the ARRL web site, but at the moment the ARRL errata section just contains a link back to his site.

Some folks on QRP-L noted that the style of drawings and schematics varies throughout the book, but I didn't find that it detracted from it at all. And if some poor draftsman had to redraw everything in the same style before publication, we might still be waiting for the book 4 or 5 years from now.

Where does this book fit in the large gap between the earlier Hayward works, *Solid State Design for the Radio Amateur* (co-authored with the late Doug DeMaw, W1FB) and *Introduction to RF Design*? There's quite a difference between those two, with one written at the hobbyist level and the other at the college textbook level. *EMRFD* is much closer to *SSD*. This note appears on the W7ZOI web page:

"Regarding the mathematical level: One prospective reader asked if *EMRFD* would be like the earlier *Intro. to RF Design* or the even earlier *Solid State Design*. *EMRFD* resembles *SSD* with a minimum of mathematics. There are a few places where we do use some simple analysis, places where it is really needed. But those are kept to a minimum."

The introduction portrays the book as the sequel to SSD, and emphasizes the "experimental" part. They say that this is not an encyclopedic collection of facts and things that theory says "should" work, but rather consists entirely of things that they have actually experienced themselves. And it's stuffed full of practical circuits that we can build, ones that they have already built themselves.

The bottom line-this may be a rather hefty chunk of change for a book, especially for those on a fixed income, but it's a good value, especially with the additional material on the CDROM. I think it's safe to predict that this is going to end up as another classic like SSD.

—de WA8MCQ

DDS and the QuickieLab

Joe Everhart, N2CX of the New Jersey QRP Club and member of the QRP Hall of Fame, presents #45 in his long series of Technical Quickies:

Integrated circuits are revolutionizing all types of electronics gadgets these days. It's almost trite to say, but they do this by, well, integrating lots of components into individual functional packages.

In the past, this meant digital circuits such as logic gates, flip-flops, etc. This has progressed from so-called Small Scale Integration (SSI) which incorporated simple circuit functions, through Large Scale Integration (LSI) which put whole devices such as frequency counters, multiple display drivers, phase-locked loops, large multi-megabyte RAM and ROM chips, on to whole microprocessors and microcontrollers. The current rage is the SOC or Systems-On-Chips.

On the analog side the progression has gone from simple amplifiers (op-amps, RF amps) to more complex devices such as active filters, RF mixers and IF amplifier chains and currently to almost entire radio receivers and transmitters on a single semiconductor package.

What's more there is a middle ground in which large digital chips are used to perform what in the past were entirely analog functions. Examples becoming increasingly familiar are digital signal processors (DSP) and direct digital synthesizers (DDS). Based on non-critical, drift-free digital circuits (sometimes with 100s of thousands or even millions of transistors on one chip!) they make possible the inexpensive, tiny two-way radios, cell phones and other hand-held personal communications devices that are increasingly familiar.

This Quickie focuses on one such chip from Analog Devices, the AD9850 direct digital synthesizer chip. Info can be found on the web at http://products.analog.com/products/info.asp?product=AD9850

The application to be described uses a DDS daughtercard that plugs into the NJQRP QuickieLab. Both of these are available in kit form from NJQRP (http://www.njqrp.org) but you can roll your own DDS project.

We won't look as much about what goes on inside the chip as how to feed it the information it needs in order to function as a sine-wave signal generator. It accepts serial data in and outputs a digitized sine wave output. Required external filtering and amplification is described on the NJQRP web site. Those using the DDS card with the QuickieLab only have to plug it in and load software to make it run!

Briefly, the DDS chip steps a circuit

Freq (MHz)	***dphase*** (decimal)	***dphase*** (hexadecimal)	**40-bit dphase** (hexadecimal)
1.810	77738908	04 A2 33 9C	00 04 A2 33 9C
3.56 0	152900836	09 1D 14 E4	00 09 1D 14 E4
7.040	302365698	12 05 BC 02	00 12 05 BC 02
10.106	434049395	19 DF 11 73	00 19 DF 11 73
14.060	603872402	23 FE 5C 92	00 23 FE 5C 92
18.096	777217282	2E 53 65 02	00 2E 53 65 02
21.060	904520113	35 E9 E1 B1	00 35 E9 E1 B1
24.906	1069704555	3F C2 65 6B	00 3F C2 65 6B
28.060	1205167823	47 D5 66 CF	00 47 D5 66 CF

Table 1—*dphase* values for common HF QRP frequencies.

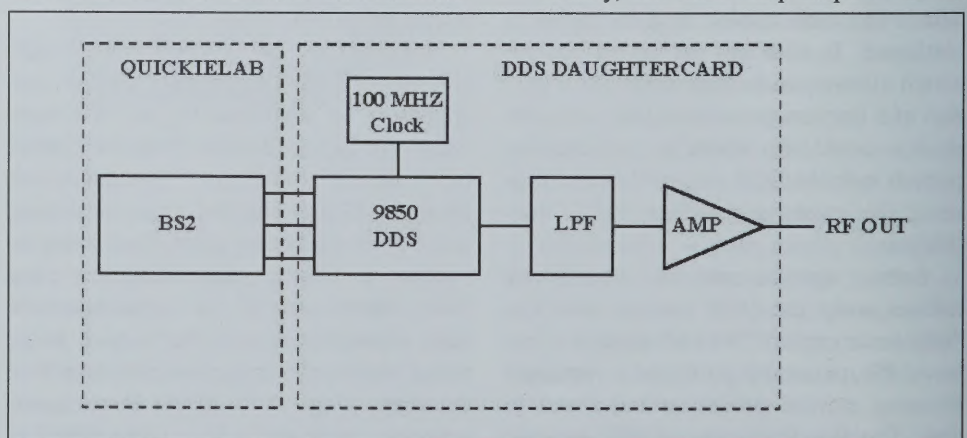


Figure 1—QuickieLab/DDS block diagram.

called an accumulator through a count specified as an input data stream. This data stream defines the phase increments needed to output the desired operating frequency. The accumulator feeds its digital output to an internal analog to digital converter to provide a sine wave output. Frequency accuracy and stability are controlled by a 100 MHz clock oscillator on the DDS card. The Analog Devices web site has much more detail on the inner workings of DDS chips for those who want to dig in farther.

Ah, but how do you figure out what phase increment values to feed the chip? The lazy man's way is to use the ADI "Direct Digital Synthesizer Design Tools" available from the Analog Devices web site. We will also see some examples of how to calculate them ourselves with nothing more than a simple scientific calculator. You really don't need to do this, but I like to run through the exercise to get a feel for what's going on.

ADI provides a simple formula for the phase increment:

dphase = *Fout**2^32/*clkin*

where *dphase* is the phase increment, *Fout* is the desired output frequency and *clkin* is the DDS clock frequency. 2^32 is 2 to the 32nd power or 4,294,967,296. Combining all this results in the formula:

dphase = *Fout**42.94967296

For example the appropriate value the chip needs to output 1 MHz is 1E6*42.94967296 or 42,949,672.96 or 42,949,673 rounded to the nearest integer value. This needs to be done since the chip can't accept fractional inputs.

Values for common HF QRP frequencies calculated using that formula are given in Table 1.

The third column in the table gives the hexadecimal representation of the calculated base-10 *dphase* value. This complication is necessary since the DDS chip accepts only hexadecimal inputs (well, actually it accepts binary inputs but it's easier for humans to read when expressed in hexadecimal form). Also note that the values in the third column come from the "Parallel W1 through W4" output of the ADI Design tool. They are really the same values just expressed in reversed bit order. We use the reversed order since this is how the BS2 chip pumps 'em out.

```
'{$PORT COM1}
'***************************
'                    QL_DDS_TST
'
'               Version 0.0   Feb 26, 2003
'
'            Joe Everhart, N2CX  n2cx@voicenet.com
'
' This  program allows the NJQRP QuickieLab to exercise a DDS daughtercard.
' It is very simpleminded in that it feeds a "canned" frequency value for
' the 40 meter CW frequency, 7.04 MHz  to the daughtercard to
' demonstrate the barest rudiments of exercising the Analog Devices Inc.
' AD9850 Direct Digital Synthesizer chip.
'
' This program is written as a for Joe's Quickie No. 45 which appears in
' the WA8MCQ Information Exchange column in the Spring issue of the ARCI
' QRP Quarterly.
'
'         Copyright 2003 by J. Everhart.  All rights reserved.
'
'****************************************************
'
'{$STAMP BS2}

'***************
'START OF PROGRAM
'***************

  dir8 = 1                        'set the DDS_Load pin as an output
  out8 = 0                        'and init it to 0

  shiftout  10,9,0,[$02,$BC,$05,$12,$00] 'shift out 40 DDS mode bits on Pin
                                  '10 (clock on Pin 9) to set freq
                                  '(02,BC,05,12,00 = 10KHz)
                                  'data sent LSB-to-MSB for each
                                  'sequential 8-bit value

  out8 = 1                        'strobe the DDS Load line
  out8 = 0

end
```

Table 2—Program listing for setting the AD9850 to a specific frequency (7.04 MHz).

The DDS chip really needs a 40 bit input. You will note that the calculated values result in only eight hex digits or 32 bits. The "missing" 8 bits are used to define the startup phase for the DDS output. Since we can start at zero phase we can simply set these bits to 00. The fourth column in Table 1 shows the hex value for the final 40 bit value. Whew, almost there!

The QuickieLab feeds this data to the DDS chip across a serial interface as a rather simple data string from its Basic Stamp 2 (BS2) chip. The program line to do this for the 40 meter QRP frequency 7.040 MHz is:

```
shiftout 10,9,0,[$02,$BC,$05,$12,$00]
```

which outputs the whole required 40 bit string (five hexadecimal numbers) in the correct order which is in reversed order byte-wise from the fourth column.

Figure 1 is a high level block diagram showing the BS2 connected to the DDS daughtercard and some additional components used in a program to be described shortly. Three digital lines interconnect the

BS2 chip and the DDS. BS2 P10 is the DATA line which actually feeds the bits over, P9 is the CLOCK line which the BS2 toggles to tell the DDS that a new bit is being sent and P8 is the STROBE line that the BS2 uses to tell the DDS that all data has been sent and it should now output the frequency programmed in.

And that's all there is to it! <GRIN>

Program QL_DDS_TST is provided at the end of this Quickie that shows how to send one frequency to the DDS chip via the QuickieLab. It can be used as-is or you can change the data sent to the DDS chip to set it to any audio or HF frequency. To run it, simply load into the QuickieLab. It sets up the DDS chip which then runs continuously until you remove power.

A complete QuickieLab program was written to demonstrate how each of the HF QRP frequencies can be selected for output by the DDS. It's a tad long for inclusion here—after all this is a Quickie—so it is not available here. You can download it from the NJQRP web site at http://www.njqrp.org/quickielab/index.html (look for program QL_DDS).

QL_DDS operation is quite simple. It will operate with either a QuickieLab decked out with the whole Input Output eXtender (IOX) and LCD screen or the more basic BS2-only QuickieLab. Naturally it does need the DDS daughtercard as well.

Operation will be described assuming presence of the IOX/LCD to provide visual displays of its operation. However if you do not use the IOX/LCD, ignore the visual prompts described and simply listen for the audible Morse output that accompanies them.

After program startup the screen displays "PRESS PB2" and the Morse output is "OK" sent at about 10 wpm. To proceed, press PB2 and hold it until a beep is heard from the QuickieLab speaker. When the key is released, the screen reads "160M," the speaker sounds out 160 and the DDS chip outputs the 160 meter QRP frequency 1.810 MHz. Successive PB2 depressions step through each QRP frequency listed in Table 1.

The program is not intended as a full-function DDS VFO or signal generator, but simply as an example of how easy it is to use one the DDS chips. A more sophisticated and useful DDS signal generator will be featured as a future project. For now I'll part by reminding you that the IOX includes a frequency counter function. You can easily add commands to the program I've supplied to read the DDS output frequency and display it on the LCD screen. This is left as an exercise to the interested student.

Note: The DDS programming routine in Table 2 was shamelessly "adapted" from program QL_DDS_TST by G. Heron, N2APB. See the NJQRP web site at: www.njqrp.org/quickielab/index/html for this program and a number of others for QuickieLab

—de N2CX

Manhattan Construction on a Scrap PCB

Manhattan Construction has been around for several years, popularized on the QRP-L Internet mail reflector. It's similar to the W7ZOI "ugly construction," but instead of using high value resistors soldered to ground as isolated component tie points, this method uses small pieces of PCB material glued down to a ground plane.

This is usually done with a piece of unetched PCB material as a base, but Al McChesney, N2ZHS of Scotia, NY, has a slightly different method, detailed on his web page at: http://members.aol.com/n2zhs/n2zhspg4.html

He wanted to build the simple 7 MHz direct conversion receiver shown in *Experimental Methods in RF Design*, the new ARRL book. "The first step was to find a baseboard for the receiver to be built on. That is where I have a problem with Manhattan building. Large pieces of PC material can be quite expensive. And then you have to cut some of it up into small pieces for the pads."

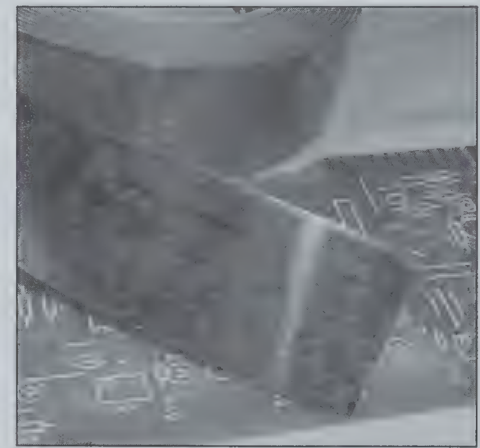


Figure 2—PCB with all parts removed and a roll of copper tape are the start for a base for a Manhattan Construction project.

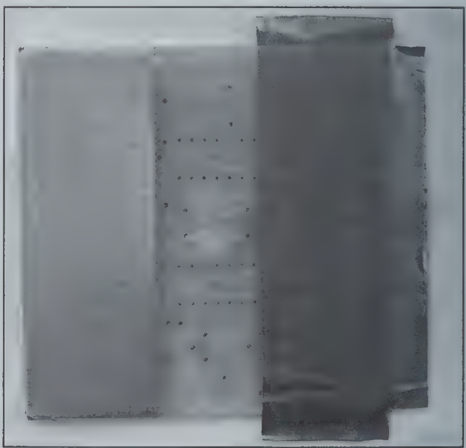


Figure 3. First, cut the board to size, then cover the top with copper tape, starting at the ends and working toward the middle.

Figure 4—Use enough tape so it can be wrapped around to the back of the board and folded over.

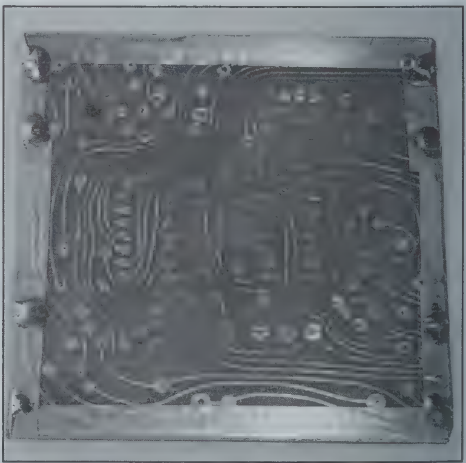


Figure 5—After the entire board is covered, solder the seams on the rear to join the pieces of copper tape.

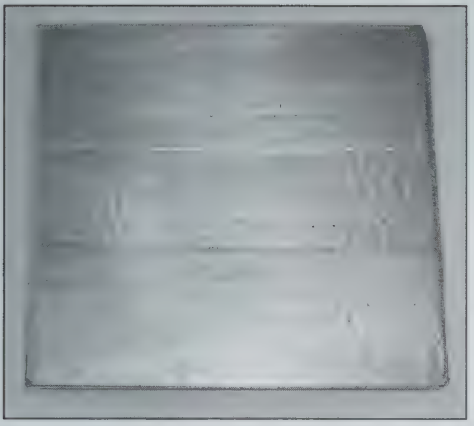


Figure 6—The top of the board is now a copper ground plane, ready to build on. (WA8MCQ recommendation: solder the seams between the pieces of tape to insure good continuity.)

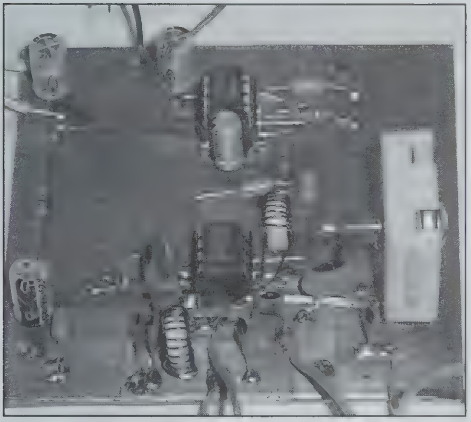


Figure 8—The finished Manhattan construction project, assembled on the "recycled" PCB.

Figure 7—The Manhattan pads are glued onto the board.

Figure 9. Manhattan pads are applied directly to the floor of the Altoids tin; no copper board is required.

Most of us have old PCBs of various sorts that we strip for parts, after which the board itself is quite useless. To Al, it becomes another resource. He stripped all the parts from a single sided board, then sanded the top smooth. Next, he filed down the solder side so there were no sharp spots. (Myself, I'd use a solder sucker or desoldering wick to clean things up, to avoid having solder shavings all over.)

Next, he cut it to size and then covered it with strips of copper tape. The tape is wrapped around on the back, where the seams were soldered. (Although he didn't do it, I'd recommend soldering the seams on the top side as well, to give good electrical contact between the strips of tape and insure a good, solid ground plane.) Finally, the Manhattan pads are glued onto the front and the circuit is built up. Figures 2 through 8 show the process.

Al also built an audio amplifier from the book into an Altoids tin. Since the floor of the tin is already a ground plane, he decided to do away with the piece of PCB material and just glue the Manhattan pads directly to the floor. (He cleaned it off first with a piece of ScotchBrite pad to insure good adhesion.) Figure 9 shows the result. (No connections have been made to the outside world yet.)

—de N2ZHS

Defective PCB Causes Problem

This info is adapted slightly from a posting on the Elecraft mail reflector (http://www.elecraft.com), posted by John Sielke, W2AGN. This is a good example of how things can go bad in the real world. The moral of the story is that when you have something that doesn't work right, check out all the obvious possibilities first and if that doesn't help, start checking things that "can't possibly be bad" or "couldn't possibly have anything to do with the problem." Sometimes it's exactly those things that are the problem. And don't automatically assume that brand new components, PCBs, mechanical parts, etc are perfectly good. Every now and then a bad one can slip through and drive you crazy.

Having worked with electronics in the real world for 33 years now, both in the Air Force and as a civilian, I've seen plenty of problems caused by something that you would never have expected. A good example is a fuse that appears perfectly good to the naked eye and yet has no continuity. I've seen that happen on both "grasshopper" and glass cartridge fuses.

This story isn't really about bad PC boards; it's about checking "all the usual suspects" and then checking everything that would never be a suspect. Here's John's story:

I was going nuts trying to get the VFO working on Elecraft K1 #1151, my second K1. I suspected the polystyrene caps, so ordered replacements. It didn't help, so I went through the check out.

The VFO actually was oscillating; I could measure it on a frequency counter and it was OK. I lost the signal at Q9, a buffer amplifier which feeds the signal to the K1 internal counter. Both the emitter and collector of Q9 showed ground, but only the emitter is actually grounded. I pulled the transistor off, and the collector pad on the board still showed ground. I looked and looked with a magnifying glass, but saw no ground connection.

Finally, I found it in the most unlikely place. There was a fault on the board itself. There is a jumper trace from C8 to Q9 on the top side of the board. One of the pads on this trace was shorted to ground at the edge. I did a little scraping with an Xacto knife and VOILA! It worked! No, this was not a solder short. That pad is never soldered to, nor was there any solder on it. A little bit of copper that was supposed to be etched away somehow remained. The short was hidden under the silk screening for Q11, so it was hard to see.

This is the first time I have ever found a bad trace on an Elecraft board. The board is "K1 2001, Rev E." I don't know if any others are like this. Probably with my luck, I got the only one. (But I did win it at Atlanticon, so guess I can't complain!)

—de W2AGN

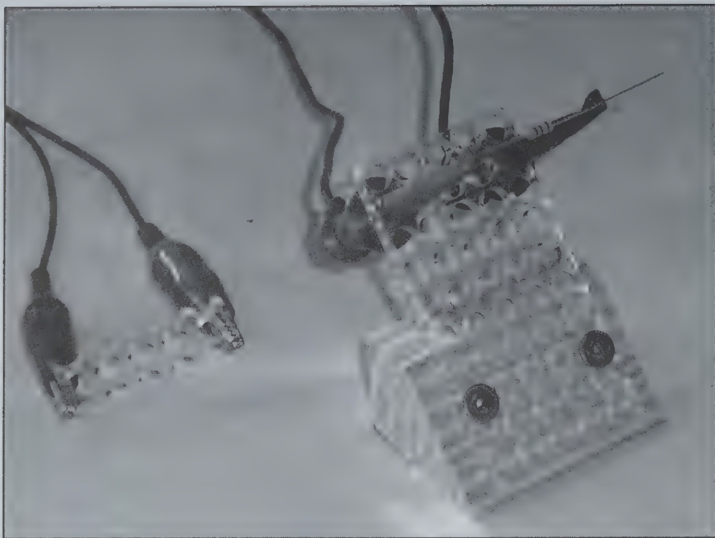


Figure 10—Plastic spacers from boxes of .22 ammo can be used to hold alligator clips or test probes.

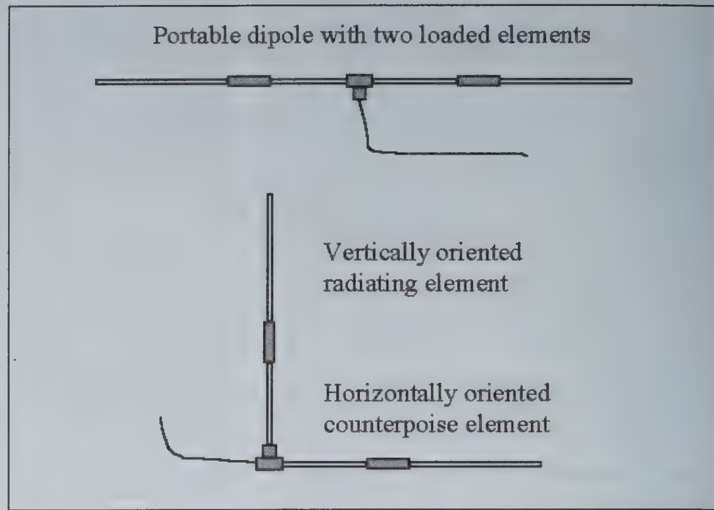


Figure 11—Portable antennas made from two loaded elements. At very low heights, the vertical element with counterpoise may give better performance.

Using Plastic Spacers from Ammo Boxes

Another note from N2ZHS—I have always wanted to do something with the plastic spacers in boxes of .22 ammo. (I'm a target shooter, not a hunter.) They have 25 or 50 holes in them, depending on the size of the box.

I found that cutting off a strip of 5 holes gives you a nice separator for wire leads with alligator clips on them, shown at the left side of Figure 10. I use the separators for the wires from my power supply, bench speaker, etc. Pulling back the boot just a little allows the 'gator clip to go in far enough so it will still close all the way. (You must use the outer edge for this, as the webbing between the inner holes is thicker.) No more shorted wires going to that project spread out on the bench.

The stand on the right side of the photo, also made from a .22 ammo spacer, holds two push-to-release clips and is shown holding a resistor. The clips have a snug fit in the holes so they can also be inserted closer together for components with shorter leads. When connected to a DVM, cap or inductor tester, it's great for checking values. With one hand, both clips can be opened at the same time to change parts.

—de N2ZHS

Portable Dipole Antenna Observations

Myron Koyle, W8FNM, sent this note recently. Myron is a former secretary/ treasurer of the QRP ARCI, and used to go by the call N8DHT until the vanity callsign program smiled on him and let him get an old call back.

I was more than a little surprised when I got my Winter (January) 2003 *QRP Quarterly* and read the review on the BUDDIPOLE antenna. [The antenna is a shortened, light weight portable dipole consisting of a pair of loaded elements.]

A close friend of mine Mel Vye, W8MV, is best known as the pre-eminent "Mini DXpeditioner." He is a retired professor of electronic engineering in the University of Akron's College of Engineering. He has been featured in *QST* in the last five years where his many one or two person, unsponsored DXpeditions have been described. A few of them were with Rick Lindquist, N1RL, of the ARRL staff.

Mel got me interested in similar treks but hardly to the dozens of off-the-path places in the world where he and his wife travel (from Thailand to China to Midway Island to Monaco, etc). The basic equipment is an ICOM 706 Mk II and an Alpha Delta Tri-Split antenna (all of which fit in an attached case or a small suitcase). I designed a small base for the vertical which gave him an alternative when balcony mountings weren't available. You can read more about Mel via the ARRL Web site.

[WA8MCQ note—According to the Alpha Delta web site, the Tri-Split is a member of the Outbacker family of short, loaded, multiband whip antennas. It covers 8 bands, from 75 through 10 meters. The overall length is 6 feet and it breaks down into three 2 foot long pieces.]

Recently Mel mentioned that he had picked up another Tri-Split. My reaction was, "So you're going to make a dipole for more oomph." His response was, in a sense, a rebuke. "If I did that my signal would go straight up." Rather, he is using the second antenna as a counterpoise (i.e. at a right angle). Figure 11 shows the two configurations.

I called my friend Dr. Bruce Robeson, W8JCC. Bruce is an Honor Roll member who stays current with the number (i.e. he doesn't rest on his laurels). Bruce has done this by designing his own all-driven element antennas. He's an amazingly creative guy in this area. Since he uses the ELNEC antenna analysis software I asked him to model a horizontal dipole for 10M and 20M to see what Mel was telling me.

Bruce called to verify that at 10' above the ground the signal does go straight up; at 20' it begins to develop a side lobe. Conclusion: For maximum performance, at these low heights you're probably better off with a vertical with a counterpoise than a dipole.

WA8MCQ comment—As is always the case with antennas, just about any given unit can give perfectly acceptable performance and yield a great many contacts when conditions are fairly good. There will always be tradeoffs between performance and other considerations, particularly in portable operation where situations can vary widely. (For example, many backpackers like to use RG-174 coaxial cable as a feedline. Even though the loss is

decidedly greater than larger cables, the reduced size and weight are important considerations when hiking and they are willing to make the tradeoff.) In many situations it may be possible to obtain better performance. Whether or not one feels the need for it and wants to put forth the additional effort (and perhaps accept different tradeoffs) is always a personal decision.

—de W8FNM

Defective Electrolytic Caps in the Supply Chain

Near the end of 2002, there was some discussion on QRP-L about computer motherboards developing large numbers of leaking electrolytic capacitors, and I had also heard of this happening with camcorders. This is apparently a problem that has been known in the industry for a while, and details can be found at this web site: http://www.niccomp.com/taiwanlowesr.htm

The problem involves use of a particular electrolyte solution in aluminum capacitors, which can lead to premature failure. The typical failure mechanism is destruction of the rubber end seal or the aluminum can itself. In either case, the electrolyte can leak out.

The units in question are low-ESR (Equivalent Series Resistance) aluminum electrolytic capacitors made in Taiwan by various companies, using a particular water-based electrolyte. The story on the web site says, "It is important to emphasize, however, that the products that have been affected are only the low-ESR type aluminum capacitors, which account for less than 20% of Taiwan's aluminum electrolytic capacitor production volume." Just because a particular capacitor was made in that country does not necessarily mean that it will have this problem.

This may affect a number of us since we all have consumer type electronic equipment; although I mentioned motherboards and camcorders, this can happen to any consumer electronic item. Not only that, but there is always the possibility that some of these defective parts may end up in surplus electronic component circles. You might want to keep this in mind when purchasing surplus electrolytic capacitors.

Again, this applies only to low ESR aluminum electrolytic capacitors made in Taiwan by certain companies, and according to the online article not all Taiwanese manufacturers used this bad electrolyte. And I would expect that such parts made by these companies after a certain date will be perfectly good.

—de WA8MCQ

K2 On-Frequency Receiver Overload Mod

When nearby transmitters are operating on the same frequency as a K2 there can be some audio distortion. Wayne Burdick, N6KR (n6kr@elecraft.com), posted this simple fix to QRP-L:

Several recent HF Pack [mail reflector] postings described K2 received audio distortion ("Howling K2s") in the presence of nearby transmitters operating on the exact same frequency as the K2. We reproduced this in our lab and came up with a very simple modification that dramatically increases the K2's on-frequency extreme signal-handling capability. The mod uses just two 1N4148 or 1N914 diodes; details appear below. We have modified five K2s as described, and they all worked perfectly.

In hindsight, we should have included the two diodes in the original design. The reason we didn't notice this sooner is that the test suite used by most RF labs, including ours and the ARRL's, does not include a test of extremely strong on-frequency signal handling. The K2 passes all of the usual dynamic range tests with flying colors, as has been well documented. But these tests all use weak signals within the K2's crystal filter passband; large signals are injected outside the passband (usually 5 to 20 kHz away).

Those tests are looking for desensing of the receiver when strong off-frequency signals are present and for intermodulation products from strong off-frequency signals that produce on-frequency interference that masks desired weak signals. The K2 excels in these areas and tops most current rigs on the market.

Of course if we had been doing our share of HF Pack operation, we would also have discovered this problem sooner! Operating multiple rigs on the same frequency, all within walking distance of each other, was something that never occurred to us when we designed the K2 and released it in 1999, prior to the big upsurge in HF Packing that occurred in 2000. Thanks to all who did tests and let us know what was going on. We believe someone demonstrated the effect to Wayne at SeaPac 2002, and we apologize for not looking into it then.

Modification Details—This applies to all K2s regardless of serial number.

1. Solder a 1N4148 or 1N914 diode (or equivalent) between pins 4 and 6 of the IF amp (U12, MC1350). The cathode (banded end) should go to pin 4. Do this on the bottom of the board using very short leads.

2. Solder a second diode of the same type between the same two pins, but with the banded end toward pin 6.

Results—With the diodes in place, we've been able to transmit at 100 watts into an antenna just a few feet from the K2 (with its own antenna) with no apparent K2 receiver problems. In these tests the receiving antenna was non resonant. But at the lower power levels used for HF pack operation, there should be no problem even with resonant antennas operating in each other's near field. Fast and slow AGC still work normally.

Technical Details—The MC1350 IC used in the K2 for receive automatic gain control (AGC) can handle up to about 2.5-3.0 V peak-to-peak at its input, pin 4. Beyond this, the AGC becomes ineffective, and the product detector can be overdriven. Normal on-air, on-frequency signals are generally under 200 mV at pin 4 of the IF amp, even at "S9 + 40 dB" as indicated on the K2's S-meter. But when you inject an extremely large signal from a nearby transmitter on the same frequency, the signal can go as high as 7 Vpp unless it is hard-limited.

The two diodes limit the signal to 1.4 V peak-to-peak. Even when the diodes are conducting, i.e. when the signal is so strong that it looks like a square wave at pin 4, there is no audible signal distortion. This is because the MC1350 is followed by a second crystal filter which removes any harmonic distortion products (i.e. multiples of 4.915 MHz). The diodes appear to have no other side-effects.

The modification provides a large increase in on-frequency dynamic range by acting as a clean limiter. Most commercial rigs use multiple IF amp stages to achieve this, but this adds a lot of complexity, adds significant IF noise and increases current drain, which is not compatible with the K2's intended use as a battery-powered field radio. It is also unnecessary; the K2's gain distribution is such that the diode limiter will never interfere with received signal quality.

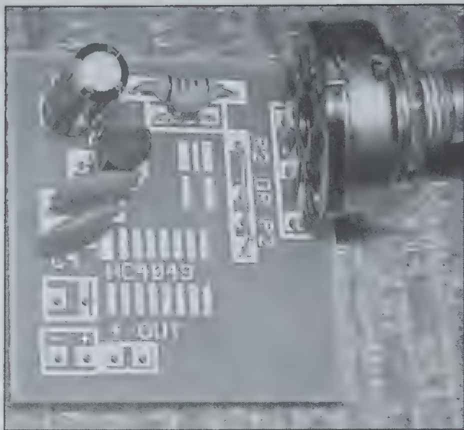


Figure 12—Top view of the VFO kit.

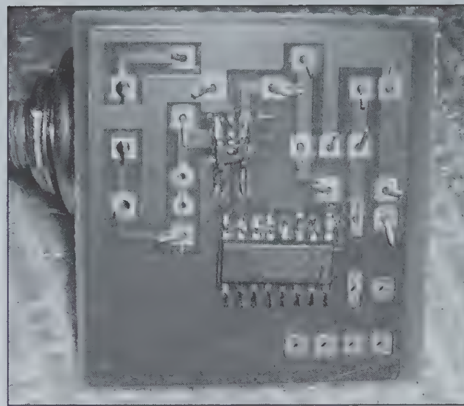


Figure 13—Bottom view of the VFO. The LTC1799 can be seen above the left end of the larger IC.

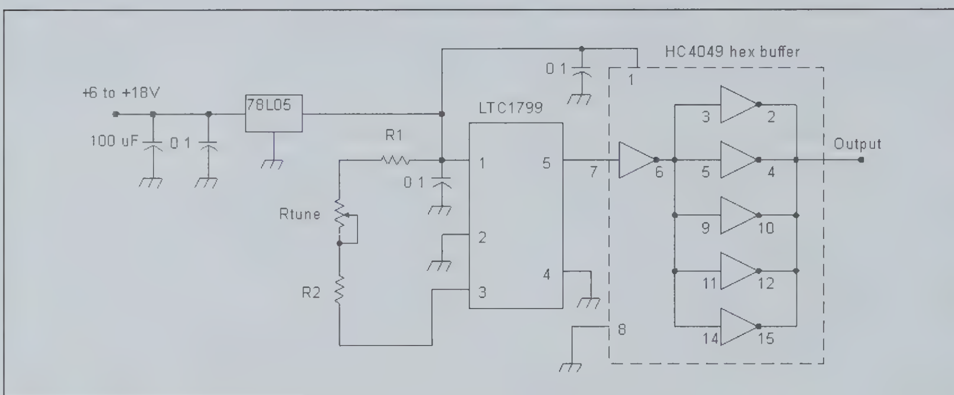


Figure 14—Schematic of the VFO kit. Output frequency is determined by the values of the resistors connected between pin 3 and Vcc.

If you make the modification, please let us know if it cures any observed audio anomalies as described earlier. If results are universally positive, we'll incorporate the mod into new K2 kits immediately.

—de N6KR

VFO With LTC1799 Chip Doesn't Pan Out

Late last year, advertisements started appearing for an inexpensive VFO kit, using the Linear Technologies LTC1799 chip. At first it showed great promise, since the frequency is controlled by a variable resistor and has a large range (from 100 KHz to over 30 MHz). Unfortunately, like the programmable Epson oscillators (available at DigiKey) that came out a couple of years back, this one doesn't appear to be terribly useful for our type of RF applications, due to some signal quality shortcomings.

Some of the ads used the name Datak, and kits with that name were apparently sold by Ocean State Electronics. I bought mine from DC Electronics, having ordered from a different ad, and it was not identified as Datak. According to a post on QRP-L, the product was later removed from the market due to the shortcomings, which are inherent in the chip itself.

Someone posted an e-mail he had received from the manufacturer, who indicated that they could return it to the place of purchase and he would arrange for them to give a refund. In December I traded mails with the same person, TheseusRob@cs.com, and he told me "Please return the VFO to the place from which you purchased it; let me know if [there is] any problem with that." (I later decided to keep mine. If you still have one and want to return it, it might be a good idea to check with whoever sold it before sending it back.)

Figure 12 shows the top of the VFO board and Figure 13 is the foil side. The two ICs (oscillator plus buffer/driver) come preinstalled since both are surface mount parts. The LTC1799 is in a 5 pin SOT23 SMT package, and barely visible above the left end of the larger chip, just below the centerline of the tuning pot.

Figure 14 shows the schematic. The frequency is determined by the resistance between Vcc (pin 1) and pin 3. The kit comes with a value of R1 and Rtune that will cover the entire 40 meter band; in this case, R2 is just a jumper. The tuning range can be varied by careful selection of all 3 resistors, as well as the wiring of pin 4, which is grounded here. This tristate pin controls an internal frequency divider; when grounded, the divider is disabled; when floating, the oscillator output is divided by 10, and by 100 when tied to Vcc. The other chip is an HC4099 hex buffer, with 5 of the sections wired in parallel to increase the available drive power.

The output of the board is a square wave, not sine. This is not necessarily a problem since the output can be passed through a simple filter when a sine wave is required. Many applications, such as digital circuitry, can use the square wave directly, and many RF mixer circuits will perform better when driven by a square wave. The main problem is that the signal is not stable enough or clean enough for serious receiver use, and certainly not for use in a transmitter. (The instructions that came with my kit included circuits for a 40M transmitter and a simple NE602/LM386 receiver.) There also appear to be some temperature stability problems.

On the QRP-L, someone reported that a friend built one to use with a QRP rig and had stability problems with it—"it would not stay put on one frequency." Someone else reported that the chip has some inherent jitter on the output, which would translate into FMing on a transmitted signal.

Chuck Olson, WB9KZY, recorded a short audio file from a receiver tuned to the VFO and put it on his web page. You can listen to it at: http://jacksonharbor1.home.att.net/ltc1799.wav

It almost sounds like some sort of digital ham signal, with plenty of warble. He also charted the output frequency to show drift from a cold start; that can be seen at: http://jacksonharbor1.home.att.net/ltc1799b.gif

Also on QRP-L, James "Dr. Megacycle" Duffey, KK6MC/5, said "…that ragged square wave can be used as a signal generator for non critical applications. It will fill the bill for simple alignment of receivers, for example. A low pass

filter will clean up the signal considerably [if a sine wave is desired—WA8MCQ]. Tony Fishpool, G4WIF, and Graham Firth, G3MFJ, use this chip for a signal generator in their book about low cost test gear [*Simple Test Equipment for the QRPer*—ed.]. It is not suitable for receiver applications, other than the most crude."

The bottom line-an oscillator using the LTC1799 chip does not appear to be stable or clean enough for serious RF work, although it can be useful in many other applications.

—de WA8MCQ

High Voltage Safety

While most of us use solid-state equipment which uses low, safe voltages, some people like to play with old vacuum tube equipment or build new tube QRP rigs from scratch. (A good example is the "Altubes" tube transmitter in an Altoids tin by Monty Northrup featured in the Winter issue.) When I started in ham radio in the '60s high voltage safety was second nature to most hams, since virtually all equipment at the time used tubes. (And after getting bit a time or two, you learned to be careful very quickly!) But as the years passed tubes faded away and solid state took over, and high voltage safety awareness probably decreased as well.

Here are a few QRP-L posts on the subject, starting with one from Stuart Rohre, K5KVH (rohre@arlut.utexas.edu). He posted this after someone "wondered aloud" whether anyone wore latex gloves while working inside tube rigs.

It is true the latex gloves may not be worth the effort, especially as they cause your hands to sweat. Electrical gloves are thick rubber inside leather and are too bulky for work on ham gear. Latex hospital gloves [which are readily available in drug stores—WA8MCQ] cut and tear easily. Even household rubber kitchen gloves can develop pinholes after a little use. To test gloves, electricians whirl the glove at its opening to entrap air, then immerse it in water and look for bubbles at pin holes in the palm and finger areas. Of course, this is not done the day you plan to use them! It is done before hand, and on a regular basis, but then the gloves are dried thoroughly.

The tried and true standard practices with tube supplies and high voltage are to always turn off AC power, discharge high voltage capacitors, and unplug the power cord before putting your hands inside the chassis. A good practice is to take a nylon cable tie and put it thru the power cord so it cannot be plugged in by error while you are inside the danger area.

Always hook up voltage test leads using clips on an electrically cold chassis before applying power, and do NOT hold test leads in the hands! It is too easy to either have the hand slip down to the conducting tip, or lean the probe sideways, shorting into a ground when you glance away at a schematic.

[WA8MCQ note—Unfortunately clipping on all leads is not always practical. In my USAF days I had to troubleshoot tube equipment with the power on sometimes, and had to poke an oscilloscope probe all over the place. But the probes were well insulated except for the very tip, and we had one basic safety practice drilled firmly into our heads from Day One: one hand holds the probe and the other hand goes in your pants pocket. That way, it couldn't be touching the chassis or other grounded object. If the hand with the probe slipped and contacted a point with high voltage on it, there would not be a direct current path from one hand to the other by way of the heart. And of course we were also required to stand on rubber mats when working on the equipment.]

The only high voltage that should be exposed from the front panel is the cathode voltage on a key jack and hand key. With a clear plastic box, such as sold at Container Stores, or for thermostats, you can fashion a safety cage over your key. Or find and use the flameproof (covered key contacts) Navy keys used for signal lights, etc.

Be sure and build your tube circuits with good attention to shielding and insulation since you are working at higher voltages than the usual QRP transistor set. Make sure you do not leave work that is out of the case where any family member (child or pet) could come across high voltage. Lock your shop, or put a box over a chassis sitting on the bench. A good safety cage box is one of those plastic milk crate things, or a laundry basket inverted over the chassis.

Having it impossible to plug in is best. That means, for new construction, using the IEC 3 wire AC chassis connectors which require a removable AC cord. [This is the type widely used on computers and monitors.] The nylon tie or other lock out method could be used on antique equipment with permanently attached power cords.

Do not work on live equipment! Take the time to do it right, and do not do it when tired or distracted!

It is amazing we all lived this long to be able to remember these incidents where we did not work safely, or did not know the dangers in our old AC/DC ham receivers when Novices.

—de K5KVH

In reply, George "Yellow Rose of Texas" Baker, W5YR (w5yr@att.net) had this to say:

As always, Stuart and I seem to be reading from the same books, and I know that we have traveled down a lot of the same paths.

But, on just one point, I must sadly differ with my learned comrade: directly keying ANY sizeable voltage with a hand key. I, too, grew up cathode keying 6L6 oscillators and 807 drivers, etc. and got my share of "rude awakenings" late on a hot summer night with sweaty hands touching the wrong part of the key.

My solution and my advice is to do all such keying either electronically (preferred) or with a simple keying relay. Depending on the voltages and currents involved, you may be able to get by with a simple reed relay or one of the more advanced relays from Radio Shack. Cost is low to moderate in any case. Controlling factors are ability to withstand open-key voltage without arcing, carry the key-down current without exceeding contact ratings, and be agile enough to follow your keying. Most small relays draw little current and can be energized by simply keying a small battery supply of a few volts.

The design approach is to build the transmitter and then measure the key-up voltage present at the keying point—do this with a DMM—and then measure the key-down current, again with the DMM but set to read current. Those two values will give you the info you need to select a relay. The remaining issue of coil voltage is resolved by what is available that meets the chief criteria of contact current and voltage. Finally, "audition" a trial relay for speed to make sure it can follow your bug or whatever.

I recall "in the old days" that Guardian made a relay specifically for cathode-key-

ing high-power transmitters. The contacts were about 1/4" in diameter, made of coin silver, with a gap of about 3/16" when open. The coil and the return spring were so strong that then the key was closed, the relay would "whap" to close the keying circuit. It made a great keying monitor once you learned how to read all those "whaps."

If I had to design a keying setup today, I think I would start with a simple 2N2222 or 2N3904 switch transistor and battery and use it to key a small relay which would in turn either cathode-key the rig or, my preference, apply and remove the bias voltage to a vacuum-tube blocked-grid keyer.

In my youth, I built the classic "vacuum tube keyer" that was described in the *ARRL Handbooks* for several years both before and after WW2. It used four type 45 triodes in parallel to switch the cathode of an 807 driver for an 813 final. A small built-in bias supply cut the switch tubes off when the key was up and the key merely removed the blocking bias for conduction. An RC circuit or two controlled the make and break time constants and allowed for a wide range of keying waveshapes. The 813 final was self-keyed using a screen clamp tube (6Y6?) whose grid was biased by rectified grid current from the Class C 813. You newbies can look all that stuff up in the old *Handbooks* as part of your introduction to the wonderful world of vacuum tube transmitters.

—de W5YR

Finally, Mike Branca, W3IRZ (w3irz@att.net) had this comment about keeping things in perspective and not going too far off the deep end after a number of other people had commented on the topic of high voltage:

It seems to me that a lot of you fellows are so afraid of electricity that you must turn off the main breakers to change the light bulbs in your house. Let's not pass this irrational fear to the younger folks who assume that just because we are older that we are stating such things as facts. Caution is good but let's not get carried away. Actually most of the older tube type equipment can be improved safety wise by adding a 3-wire cord and plug. This will put a ground on the cabinet and drain the transformer leakage and AC noise filter capacitors so that no one will get tingles from touching it.

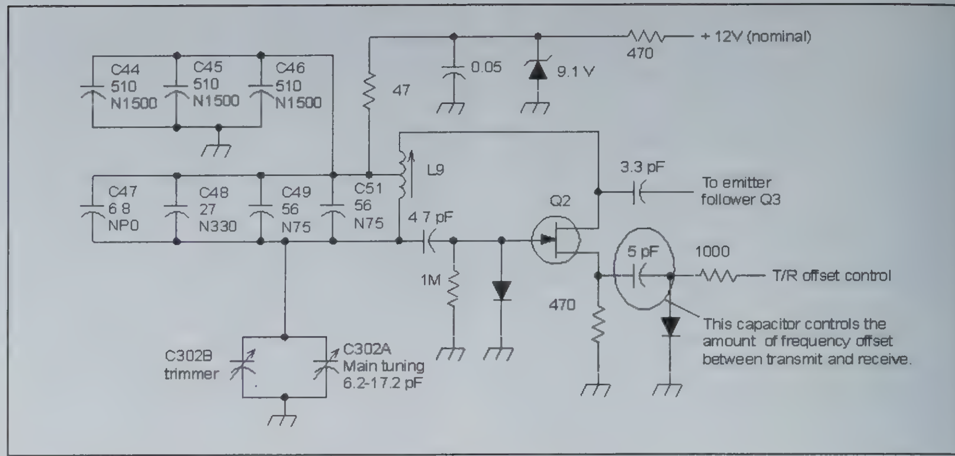


Figure 15—The T/R frequency offset of the HW-8 VFO is controlled by the value of C55, a 5 pF capacitor.

Years ago it was common to use the neon AC testers by holding one terminal with your fingers and touching the other to the cabinet. If it glowed you inverted the AC plug 180 degrees and checked again. If it still glowed then you put the set directly on the workbench to find out why. There was no shock in touching the neon tester as the current had to go through the neon bulb as well as a 220k resistor—not much current there.

Actually, if you are familiar with working on anything that plugs into the AC line then you will find that working with tubes is no different. Just about every desktop computer power supply has some interesting voltages inside. It starts with a voltage doubler to give 250-300 volts into the switcher. You want to be careful if you decide to tinker with them especially as it is not always clear which wires or parts have these high voltages.

Let's be careful and have fun too. Reasonable cautions have been listed in the *ARRL Handbooks* for years so it may be prudent to read up on the subject. Latex gloves are designed to protect against other things and I would not trust my life with them for high voltage as they are much too thin.

—de W3IRZ

Changing HW-8 T/R Frequency Offset

I mentioned this item quite a few years ago, but it bears repeating because the subject comes up occasionally. Every now and then someone will ask how they can change the amount of frequency offset between transmit and receive in the HW-8. Figure 15 shows the schematic of the VFO, and indicates which capacitor controls the offset. It's C55, the 5 pF capacitor connected to the source of Q2.

In most cases the owners are not happy with the shift they have and want to tweak it a bit; for instance, the value of the capacitor may have changed significantly over time. In other cases it's wildly out of whack. I remember one case where someone bought a butchered HW-8 that had been worked on by a previous owner who was "technically challenged." A number of components in the rig had been changed randomly in an apparent attempt at fixing something, and many of the new ones had values nowhere near the correct ones. One of those was this capacitor, which had been replaced with a much larger value. (Unfortunately, over the years I've heard of a number of similarly butchered HW-8s.)

The line marked T/R Offset Control is actually the same line that drives the T/R relay. The cap can be replaced by a new one, or a small air variable trimmer could be used instead to give some control over the amount of offset.

—de WA8MCQ

Toroid Calculator Program from W8DIZ

Here's a nifty free program for calculating the number of turns needed to get a certain inductance on a toroid, as well as the length of wire required. Its availability was announced in December on QRP-L by Dieter ("DIZ") Gentzow, W8DIZ of Loveland, Ohio, w8diz@fpqrp.com. He runs a small business selling parts for QRPers. The URL of his operation is: http://www.partsandkits.com (It used to be http://www.kitsandparts.com until he

changed servers recently.)

Among other things, he has some good prices on a variety of toroids if you don't mind buying in batches of 25 or 100 per value. (He carries a relatively limited number of types; if you need other types or smaller quantities, I'd recommend going to CWS Bytemark. Bytemark was started several years ago by QRPer Tracy Markham, N4LGH, and it was recently merged with CWS. The combined company includes a number of former employees of Amidon. Their URL is http://www.cwsbytemark.com/)

Dieter solicited some beta testers on QRP-L, asking for comments and suggestions, and released some newer versions; the latest is 1.4.1. You can find it on his web page by clicking on "TOROIDS" and then clicking on "Download the latest Toroid Calculator."

The two choices are: "Toroids.zip Version 1.4.1 (includes runtime)" and "Toroids2.zip Version 1.4.1 (without runtime)"

The first file is 732k. When unzipped it produces the 108k toroids.exe, a small .INI configuration file, a pair of files for illustrations (a JPG and an HTM file) and a 1.3 megabyte DLL runtime library which may already be on your computer under Windows\System. The version without the runtime library is 41k. It has everything except the DLL, and will work by itself if your version of Windows already has the necessary file (msvbvm60.DLL).

Run the program and the screen shown in Figure 16 pops up. Enter a value in the L/Ind μH block, hit <ENTER>, and numbers pop up instantly in the 13 blocks on the right of the screen (Figure 17). These give the number of turns and length of wire to obtain that value of inductance on 13 of the most commonly used powdered iron and ferrite core types.

The toroid types are hardwired into the program and cannot be changed. To calculate the number of turns for other types, you'll have to get your scientific calculator and punch numbers into the standard toroid formulas. (In a future issue I'll talk about a free toroid calculator that can be downloaded from Micrometals; it only does powdered irons, but it does all sizes and material types.)

If you also enter a frequency on the left of the screen, the program calculates the amount of capacitance needed to resonate the coil at that frequency, and it also gives the reactance. (That's also the reactance of the capacitor, since XL = XC at resonance.)

The instructions ("Help") are simple enough. "Fill any of TWO fields on the left side of the form and hit the Enter key. This will fill in all the other fields with data. You can also enter a TURNS number for any of the toroids as one of the fields in place of the Inductance field. Once all the fields contain data, you can change any field's value and the program will recalculate all the fields based on the Frequency value." You can use either the mouse or shortcut keys (F, C, L, Z) to jump between Parameters blocks. Shortcut key E will erase all fields to let you start over.

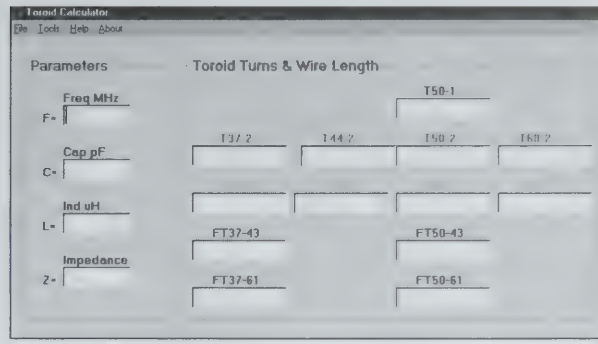


Figure 16—Opening screen of the W8DIZ toroid calculator.

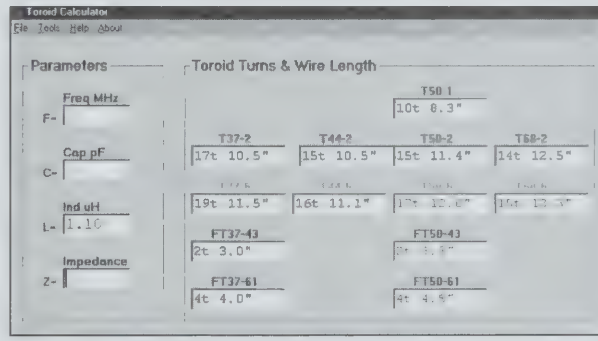


Figure 17—Punch in an inductance value (left) and the number of turns and wire length is automatically calculated for all toroid types.

Another interesting feature is that you can key in a number of turns for any one of the cores shown and hit Enter, and it will automatically compute and fill in the number of turns (and wire length) for all cores as well as show the inductance. (It won't give frequency, capacitance or Z until a second block is filled in on the left side.)

The program gives results for the following cores: T50-1, T37-2, T44-2, T50-2, T68-2, T37-6, T44-6, T50-6, T68-6, FT37-43, FT50-43, FT37-61 and FT50-61. While this won't cover all of the cores that a QRPer might use, it does cover the most common ones and should be quite useful.

When I first played with the program I wondered if the wire length included any allowance for leads, or if it was exactly the amount needed to wind the turns and nothing more. Dieter told me to click on the Parameters button under Tools and scroll down a bit. It turns out that it does include a little more wire for leads, with a default value of 2", giving a pair of one inch leads.

The Parameters section includes a number of different settings for the program. Some should not be changed, such as the A_L value and the length per turn for various core sizes. Two others can be changed with impunity. One of them selects either inches or centimeters. The other variable, XL, is the amount of additional wire that is added for leads. This would normally be left as XL = 2, since 1" leads should be suitable for the vast majority of cases.

Also under Tools is Attenuators, a handy routine for calculating the values of resistors to make an attenuator of any value you want. The default impedance is 50 ohms, but that can be changed. The values are shown for both T and pi attenuators, and the values are the exact ones required. (It would be handy if the program also gave values for real resistors, such as 1%, 5% and 10%; in the next issue I'll talk about a free 16 year old DOS program that does just that.)

Also under Tools is a button called TechData. This contains some information on a large variety of powdered iron toroids, and appears to be taken from the Micrometals catalog.

Back on his web page, also under the Toroids section, he has some additional info that isn't in the program. "Winding help" gives some tips on winding toroids, and "Turns" shows the maximum number of turns of wire of various sizes that will fit

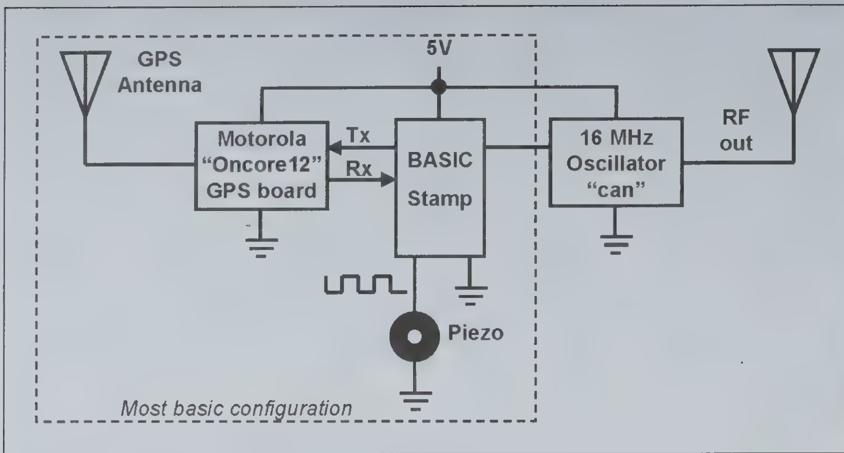


Figure 1—Diagram of the GPS-to-Morse system.

Figure 2—GPS-to-Morse box and antenna.

(in a single layer) on various cores. The latter is helpful when you have more than one size of wire available, and can help avoid the embarrassment of winding a toroid and finding out too late that not quite all of the turns will fit.

If anyone wants a copy of the W8DIZ toroid calculator program but can't download it for some reason, let me know and I'll mail a floppy with it at no charge.

—de WA8MCQ

Micro Moments #4:
Use a BASIC Stamp to Send GPS Positioning in Morse Code

By George Heron, N2APB, email: n2apb@amsat.org

One of our club members came up to me at a recent NJQRP meeting and said, "Tune your FT817 over to 16 MHz and tell me what you hear." I was intrigued because I didn't have a clue what service was assigned to that frequency. When we started copying the Morse transmissions ("40,21.3350,N 074,36.8327,W") it became apparent what the data was—lat/long positioning information from a GPS satellite. But how were we able to read it on this frequency?

Robert Evans, N2LO cleared up our confusion by explaining that he had placed a small box outside the building containing a micro-power transmitter sending the latitude-longitude data from a small GPS receiver controlled by a BASIC Stamp microcontroller. Neat! But I had to learn more, and what Robert shared with me illustrates what can be done with simple components and a BASIC Stamp controller.

The heart of this system is a Motorola Oncore12 GPS board. A surplus vendor (BG Micro) recently had a bunch of these little circuit boards on sale for $24—quite a deal! TAPR also used this board in their GPS projects, and you could still likely find some around at a good price. Construct a 1.5 GHz GPS antenna for next-to-nothing cost (Oct 2002 *QST*), add a 5V power supply and you get a stream of NMEA-encoded ACSII data coming from the board at a 4800 bps serial rate.

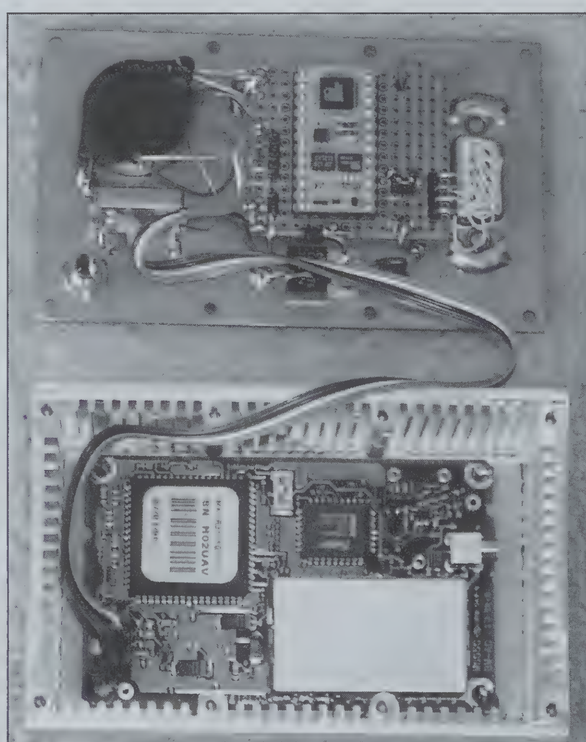


Figure 3—The GPS receiver board is a mere 2" x 3" and sits in the bottom of the enclosure. The BASIC Stamp controller mounts under the cover. Not too complex!

N2LO programmed a BASIC Stamp microcontroller with a simple program to read that NMEA data stream and convert the text characters to Morse code, as annunciated using a piezo sounding device mounted in the box. The BASIC Stamp comes from Parallax.com and can be programmed using their free editor and serial downloader. The Stamp costs $45 (ouch!), but you could also use the HC908 Daughtercard at about half the price from the NJQRP Club, or even a PIC microcontroller for an even cheaper solution. The software for the Stamp and the HC908 controllers is located on the NJQRP website for this project—it's the homebrewer's choice as to which way to go! (Visit www.njqrp.org/gps2morse for all the details, software listings, vendor contact info and references.)

The 16 MHz oscillator module was included in the box to provide a convenient way of getting the data when the GPS receiver is remote, as was demonstrated at our club meeting.

It's often fun knowing exactly where you are when operating in the field. A device such as this (without the 16 MHz oscillator) could form the basis for a more elegant and useful piece of gear you could take on your next QRP outing in the mountains or along your favorite miles of beach. You could modify Robert's software to accept more of the GPS data coming down from the "bird" and display latitude, longitude, elevation, speed, heading, time, and satellite status information as fre-

quently as once per second on an LCD. This is a perfect project for the Digital QRP Breadboard (HC908 Daughtercard project), and you'll see the project details and software for this solution on the website too.

What applications can you come up with? Whatever they are, you can rest assured always knowing where you are!

QRP Online

Regular readers can probably quote this section from memory, since I've been ending the column with this for years now, and most of it is repeated verbatim each time. As I say every issue, there's been a huge amount of QRP info flying around the Internet for years, and it's still there! Here are some of the online forums available:

QRP-L, which I call the "QRP Daily," is the online QRP discussion forum started in 1993 by QRP Hall of Fame member Chuck Adams, K7QO (K5FO at the time). It continues to run several dozen postings per day on a variety of topics related to QRP.

QRP-F is an alternative QRP forum started by the QRP ARCI in October 1999 to take some of the load off QRP-L. The activity is much lower than on QRP-L, but so is the noise level.

While not specifically a QRP list, the Elecraft reflector is dedicated to owners of those products, most of which are QRP. Even non-owners may find it interesting since they cover a number of homebrew topics.

The HFPack mail reflector is another non-QRP list that has many interests in common with QRP. This one is for people who like to operate portable with HF equipment (bicycle mobile, backpacking, etc).

To check out the online QRP world, go to these URLs:

QRP-L: go to http://qrp.lehigh.edu/lists/qrp-l/ and you're at the home page where you can sign up, read the archives, etc.

QRP-F: go to http://www.qrparci.org/ and click to enter the site, then click on QRP-F on the menu at the top.

Elecraft: http://mailman.qth.net/mailman/listinfo/Elecraft to subscribe; home page at http://www.elecraft.com/

HFPack: go to http://hfpack.com to subscribe.

And while you're on those pages, don't forget to check out their lists of QRP related links; and at each link that you go to, check THEIR lists as well, since not all sites list all others. In addition to the QRP ARCI site, another excellent place to use as a jumping-off point for checking out QRP related sites is the NorCal home page, run by Jerry Parker WA6OWR, at http://www.fix.net/~jparker/norcal.html. You'll find quite a wealth of QRP info online.

The Fine Print

Have something you want to share with our readers? Write it long hand, type it, send a floppy disk, e-mail it, or even post it online somewhere on one of the QRP forums first and let me know about it. All you need to do is get it to Severn and I'll take care of editing, drawing, whatever. The readers await!

[Editor's Note—As Mike, WA8MCQ, said in his review of *EMRFD*, he is recovering from emergency double bypass surgery in February—right as we were beginning to pull together this issue of *QRP Quarterly*. That he even considered pulling together this column shows what a true QRPer and QRP ARCI Hall of Famer that this gentleman is. Personally, I think it may also be one of the best he has ever done!]

●●

A Compressed Air Powered Antenna Launcher

Alan K. Biocca—WB6ZQZ wb6zqz@qsl.net

In this article I will describe a simple compressed air powered tennis ball launcher suitable for putting lines over tall trees to install antennas. Comparisons to other methods, safety, legal issues and construction are discussed. It should be noted that the author does not warrant components used outside of, or within, manufacturers' suggestions.

Rapid Deployment Inverted-L Antenna

I needed an 80 meter antenna for the new Elecraft K2 that my son Chris, KG6LXL and I built together, so during a break in the weather I took the slingshot, fishing weight and reel out into our wooded backyard and proceeded to get the weight stuck in a redwood tree repeatedly. Seems the wet branches (we've had plenty of rain this December) present too much friction to the monofilament line, even with a one ounce sinker. After bouncing the sinker off the roof and gutter three times during the retrieve I decided it was time to escalate. I considered bringing out the archery equipment but decided instead to test out the new prototype Compressed Air Tennis Ball Antenna Launcher...

The author aiming high, tennis ball about to emerge from barrel.

There wasn't much daylight left, and the wet foliage was clearly "high friction," so I selected my heaviest weighted tennis tall, tied it on, pushed it down the bore and carefully arranged the monofilament to the fishing reel mounted next to the muzzle so it would feed properly. I didn't have time for repeat tries, so I put 75 psi in the pressure chamber and proceeded back to the tree. I positioned myself about fifteen feet from the base and aimed at a high angle to clear the tree, but keep the landing close in.

I pushed the microswitch, and the sound—a "thunggg" sort of like a cork popping out of a barrel with an echo (my daughter says it sounds like the bark of a walrus)—was followed by the hiss of the line as the ball sailed up and over the tree. It worked, however, the launch exceeded my expectations a bit.

The tennis ball flew in a high arc over the tree, more than fifty feet beyond into the backyard, and over a couple more trees. In total, about a hundred and fifty feet vertically and some eighty feet horizontally. I hadn't planned it quite that way, expecting to just overshoot the first tree, but I apparently had set the pressure a bit higher than required. The result was excellent—it did the whole inverted L wire path in one go, and the weighted tennis ball came down on its own with no fuss, so no time was wasted there.

I pulled nylon twine back over the trees to the reel and then towed the 14 gauge insulated stranded wire back up and over, stopping just before it started to come down on the far side. I will have to replace the twine with better cord if this antenna is to stay up more than a few months, but right now, the resulting antenna is approximately 60 feet vertical and 60 feet horizontal. It came out nicely, especially for one launch. I rolled out 150 feet of counterpoise in a "C" shape along the fences and retaining wall below the antenna wire, and fed it with an SGC 239 tuner. EZNEC predicts wonderful patterns from the antenna on 75 meters, and so far the signal reports have been excellent. It also tunes well on 160, though I haven't tried any contacts there. We've had incredible winds since then, and the antenna has stayed firmly in the trees.

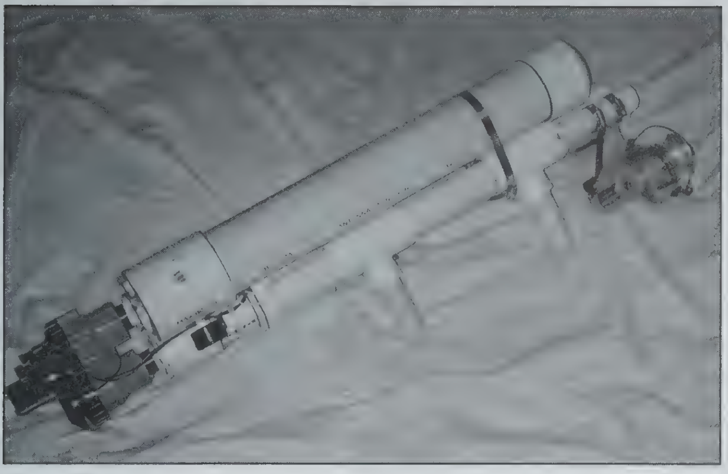
Background

About 30 years ago, on one of my early local club Field Day outings, I observed a Field Day tower snap a guy mounting ear as it was lowered. It tossed a couple of hams off the roof of a van and did some minor damage, but miraculously no serious injuries resulted. Watching this near-disaster significantly increased my appreciation for tower safety in field situations.

We started our own Field Day group a few years later. We make an annual trek to the Sierras for the event, choosing different places in the National Forest from which to operate. We've never used (metal) towers, but the forest provides trees up to more than one hundred feet tall which we use for supporting our beams and wire antennas. We commonly put dipoles and wire vee beams up to a hundred feet, and aluminum triband beams at the fifty to seventy foot mark (supported from above), yet our feet never leave the ground and we don't have to haul and set up towers in the mountains.

To put lines in the trees, we've used many techniques over the years, with archery being the most capable and slingshots the most convenient, each with differing performance envelopes. We've developed improved equipment and techniques, but there are still some issues. The slingshot is the most compact system, and will propel up to about a one ounce sinker to heights of approximately eighty feet. It requires modest strength, and has reasonable accuracy. The difficulty is in getting the weight to pull the line down once it has touched the foliage. If the tree is dry, or the branch is dead and dry, it works well. Some of the time (such as Field Day 2002), the weight won't come down.

Archery gear can reach greater heights, completely overshooting trees over one hundred feet tall. For best performance, the arrows should be heavy (I use solid fiber-



Overall view; note the electric sprinkler valve on the left.

Fishing reel and tennis ball in the barrel.

glass fishing type, but with blunt points), and additionally they can be weighted with a stack of washers at the tip (with a machine screw threaded through them and into the standard removable point socket). Pulling the line down on the far side of the tree is still a potential issue, though adding the extra weight generally helps that. It is difficult to modulate the height of the shot, so it often goes farther than desired. The bow requires significant strength and skill, and we have experienced at least one incident in which an errant launch caused minor imperfections in the hood of a fairly new Toyota pickup. Additionally, a few expensive arrows have never come down, at least while we were there.

Prior to Field Day 2002, Eric, WD6CMU, and I were discussing other possibilities. Safety and projectile cost were both high priority requirements, and Tennis Balls seemed to be the best possibility. A bit of research on the Internet turned up some ideas, and Eric built a couple of prototypes. The first one worked, but had inadequate performance, so he optimized all variables and produced a 25 pound four foot long machine I'll refer to as "Big Bertha." This monster had significantly more performance capability than we needed, and Eric used it very successfully on Field Day 2002, providing lines for nearly all our antennas. There are a few pictures on the ARRL Field Day website (see URL below) as well my large PVC slingshot. But Bertha stole the show, launching accurately and easily over the hundred foot trees at this year's site, and the three hundred and sixty foot vee beam that Mike, WA6ZTY, and Eric erected at ninety feet did an amazing job under Weo, WN6I's callsign on Field Day.

I wrote a computer model of the pneumatic system with some consultation from John Bercovitz who provided suggestions and equations for computing the airflow in the valve, which is supersonically limited during much of the launch cycle. Based on measurements Eric made from Bertha, I calibrated the software model and ran many "computer experiments" with different storage chambers, barrels, valves, and tennis ball weights.

My goal was to develop a pneumatic launcher that has adequate performance, is a reasonable size and which is easy to construct from commonly available components at low cost. The launcher described below is the first prototype from that design process.

The TBL-U37A Launcher

This Tennis Ball Antenna Launcher is a simple device consisting of an air storage chamber, valve and barrel. This model uses readily available parts—it should be possible to stop at one or two well-stocked hardware stores and a Radio Shack on the way home from work one day, pick up all the parts (except the fishing reel and line) for about fifty bucks, and build the system in a few evenings.

The modeling shows the performance bottleneck is in the valve, so I selected a Rainbird 1" electric sprinkler valve because they are readily available and have about the best flow of this valve type. The pressure storage chamber is a 3" by 24" pipe section, and the bore is a 21" length of 2.5" pipe (in which the tennis ball fits snugly). I used a 4.75" expansion chamber of 2" pipe to make the bore extend beyond the pressure chamber and to avoid having the two large couplers overlap. It would be slightly simpler to make the bore longer, but the computer modeling I did indicates the valve doesn't flow enough air and the ball will start to lose velocity in the longer bore. The overall length is under 37", chosen solely to fit between the wheel wells of my Toyota 4-Runner for convenient transport. If the pressure chamber and barrel are lengthened less pressure will be required to achieve the same performance. More performance is also possible, but probably not useful for our purpose.

Comparisons with Other Methods

How do Pneumatic Launchers compare with slingshots and archery gear? My experience is that slingshots generally are good up to seventy or eighty feet of height, and the sinkers I've used (1 oz) simply don't pull the line down well under all conditions. This is generally not sufficient to shoot over the trees we normally encounter, so you have to thread your way through the branches. I haven't tried heavier sinkers, but that would require a bigger slingshot, which I constructed, and heavier bands, which I haven't evaluated. I'm a bit concerned about the big sinker coming down—it is somewhat dangerous—especially when it gets stuck and you have to pull it back!

The Archery gear is great—I use a solid fiberglass fishing arrow and (for best results) weight the tip with a stack of washers (a suggestion from Richard, KO6TI), and a 55 pound compound bow with a large spinning reel mounted. It is a bit of a production to use, and requires quite a bit of skill and strength. It is also

difficult to regulate the height of the shot. The weighted arrows coming down are dangerous as well, and are expensive to lose when caught in a tree. The bow setup is large, fragile and fairly bulky to take to field. The equipment is also somewhat expensive, and very few are willing to procure it just for this one purpose—most antenna archers use equipment they already happen to have. In our group, this makes launching all the Field Day lines fall to just a couple of people.

The Pneumatic Launcher provides a high degree of accuracy, and very controllable velocity (height) by varying the pressure. It launches a very low cost projectile that is inherently less dangerous than a lead sinker or an arrow. The ball can be made heavy enough to pull the line down - this saves a great deal of time in the field. In my experience the time spent fiddling with the weight/arrow/line getting it to come down often exceeds everything else, so the total system time may end up being less with the Pneumatic. Finally, the Pneumatic Launcher offers significantly more performance than either the slingshot or bow. It does not require as much strength or skill to operate, though one must be strong enough to hold it when launching, as the model described here weighs about ten pounds.

The pneumatic launcher is somewhat slower to deploy for a launch than the slingshot or bow, but the increased performance and higher success rate may more than compensate. Due to the low cost and ease of use it is also possible to have several launchers available so these activities may be occurring in parallel, and augmenting the slingshot (and possibly the bow) with the pneumatic works out well—use the slingshot where it reaches, and the archery or pneumatic for the tougher paths. The additional performance may be useful to reduce the required time in some cases, as when launching an inverted L antenna in one shot as described in the example above, instead of the two it would usually take (one for each support point).

Construction Information—

1. Cutting

I use a 10" radial arm saw with a carbide-tipped blade to cut the pipe, but a hacksaw works fine. Cut it square and clean up the ends with the file and/or sandpaper. The lengths I used are shown in the parts list. Be careful when prefitting the parts, if they are put together tightly they may not be separable.

Don't cut the main handle 1.5" PVC pipe section until later, this part should be fitted for best results.

2. Gluing

Read and follow the instructions on the PVC solvent cement very carefully. There is a lot of force on these joints, so proper cleaning and gluing are very important.

The cement I used is a two-part process starting with a purple primer, followed by a clear cement. Newspaper and gloves are useful to minimize the mess. Look carefully at the photos and ensure that the few joints that are not to be glued are not done by accident.

Glue the barrel first (7 parts) and then the pressure chamber (5 parts). Glue the reel adapter ring and the front handle into the front handle tee (3 parts). The main handle needs to be fitted and will be glued later—do not glue it now.

Don't glue the rear handle until the electrical system is installed later, and don't glue the reel mount or the rear battery cover at all. Let the cement cure at least 24 hours before handling.

After the cement has cured, thread the barrel on the output of the valve (there is a flow direction arrow), and the pressure chamber on the input. I use two to three wraps of Teflon® joint tape on the threads to improve the seal. Turn them until they are fairly snug, but not so far as to crack the valve or PVC. Locate the fill valve and pressure gauge on the pressure chamber. They should be drilled through the coupler so there is a double thickness of PVC to thread into, but avoid drilling too far to the rear where the adapter stack is solid. Refer to the photos to see where to locate them. Drill and tap them. Avoid running the tap too deep—this is a tapered tap and running it too deep will prevent the valve and gauge from sealing. Before installing them, remove the pressure chamber from the valve and clean out the PVC dust from inside as this could make the sprinkler valve diaphragm leak. Reassemble and install the fill valve and pressure gauge.

3. Sizing the Separator Block

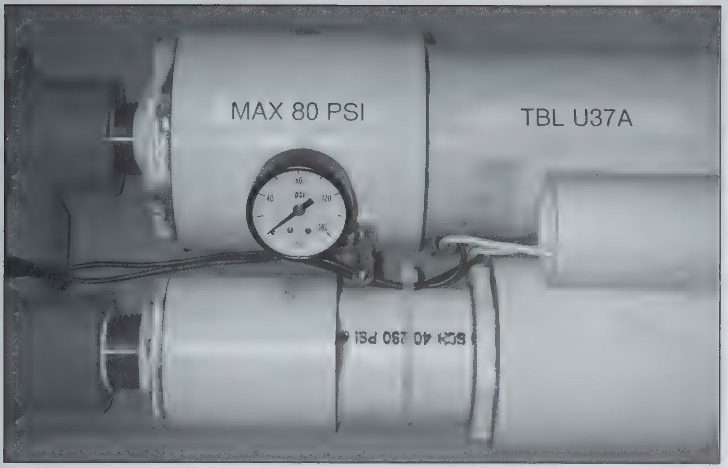
A small wood block is used to maintain the separation between the pressure chamber and barrel tubes. The goal is to keep the pressure chamber and barrel tubes parallel. The U-valve determines the spacing at one end, and the wood block does so at the other. The handle tube and the opposing sight tube should not quite touch the block, but the pressure chamber and barrel should sit firmly on it. for the prototype, I used a slice from the end of a two by four, one half inch thick. A hose clamp large enough to go around the whole assembly holds it together. Tighten the hose clamp just enough to hold everything, being careful not to distort or crack any of the PVC tubes.

4. Proof Testing

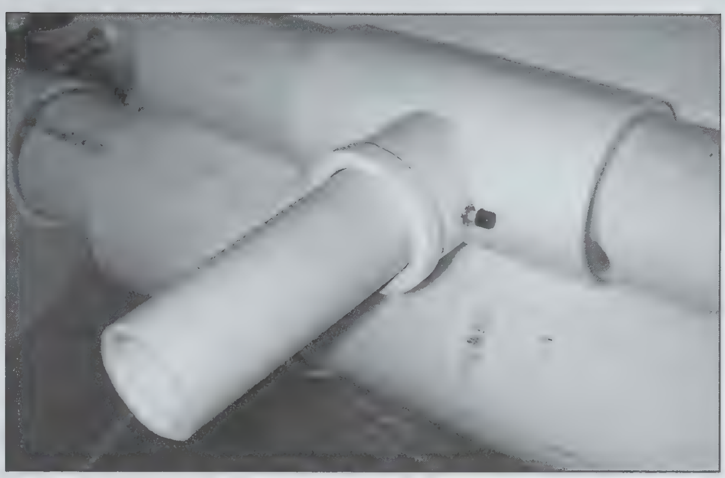
The maximum operating pressure for this system is determined by the weakest component. This is generally the electric valve, as the 3" schedule 40 PVC pipes and fittings have ratings of 260 psi and the smaller pipes have higher ratings. The Rainbird valve I used is rated for a maximum operating pressure of 150 psi. I recommend choosing a maximum operating pressure well under the valve maximum pressure. I use 80 psi as a maximum operating pressure. High pressures will only marginally improve performance as the valve is limiting the flow during the time the ball is in the bore. If more performance is required construct a longer pressure chamber and barrel.

The proof test pressure should be somewhat higher than the operating pressure; I use about 25 percent. For an operating pressure of 80 psi the proof test pressure would be 100 psi. The proof pressure must also be under the lowest maximum safe pressure of any of the components. In this case, the lowest rating is the 150 psi sprinkler valve.

Proof testing should be done after the cement has cured at least the minimum time. Wrap the unit it in a heavy old blanket, wear eye protection and gloves and pressurize it to the proof test pressure and leave it for 24 hours or more. If the pressure drops more than 5 psi, refill it to maintain the full strain on the system. If it drops too quickly, find and fix the leak(s) and retest. When the test is complete relieve the pressure through the fill valve. The proof test should be repeated periodically—such as annually before Field Day—and preceded by a careful inspection looking for any incipient problems.



Sprinkler valve, pressure gauge, fill valve.


Rear handle with trigger switch.

5. Preparing the Rear Handle Tee

I installed the trigger switch into a small hole in the rear handle reducing tee. The threads were not long enough to use the standard nut, so I used epoxy to glue it in place. The switch will be glued in later, but the hole must be drilled now before the tee is glued into the central handle tube. The switch should be convenient to depress intentionally while difficult to actuate accidentally. I placed mine fairly high to reduce the danger of unintentional triggering.

6. Handle Assembly

The handle assembly is constrained longitudinally by the pressure chamber end cap and the barrel coupler. The forward tee/handle has the reel mount, and the rear tee has the trigger switch (just a hole now). Trial-fit these tees on the assembled barrel/valve/pressure chamber. Slide the forward handle forward until it contacts the pressure chamber cap, and slide the rear handle rearward until it contacts the barrel coupler. There should be approximately 6" between them. Measure this distance. Add 2.75 inches to this (the depth of the two slip glue sockets). Cut the main handle from 1.5" PVC a shade under this sum length so the completed part will fit without too much play. Glue the two tees to this main handle tube and make sure it fits between the couplers against the barrel.

7. Electrical Wiring

The electrical system is very simple—the two battery holders, the switch, and the valve solenoid are wired in series. The only polarity concern is the battery connection, as the batteries must be series aiding to produce 24 volts to operate the U-valve reliably. Leave enough lead length to be able to slide the battery holders out for service. Solder and tape the joints, except the joints on the wires to the solenoid must be removable, so use wirenuts there. (If you want to get fancy a connector could be used here instead of wirenuts.) Install the batteries and test. The solenoid should make a quiet but positive thunk when the switch is depressed. Install the switch into the hole prepared earlier in the rear handle tube. I used epoxy for this. Take care to keep glue out of the switch. After testing, the rear handle 1" PVC tube can be glued into the tee. Take care to avoid getting glue into the switch.

8. Fishing Reel Mounting

I used a Daiwa 4000C ocean spinning reel that I had lying around, but any large to medium reel should work. Some folks prefer closed face casting to spinning reels, which is fine. The main requirement is to hold enough line heavy enough, and feed it quickly enough without catching or excessive friction, so the larger reels are best. Avoid baitcasting type reels—the spinning spool will overrun and backlash terribly!

The reel is mounted on a 5" piece of 1" PVC pipe using small stainless steel hose clamps. This pipe is inserted in the front of the handles and is removable (not glued) so the reel can be operated without holding the entire launcher. The reel is located right at the end of the bore. It is very important to avoid snags, so be sure to position the clamps away from the top front where the line will be whipping about. I often cover the clamps with electrical tape to reduce snagging.

9. Tennis Ball Preparation

I used a leather (Speedy Stitcher®) sewing awl to put a loop of tough Dacron in the tennis ball for fastening the line to. After tying a couple of good square knots I pulled them around to be inside the tennis ball to protect them from abrasion in the bore. We have not lost one of these yet, but it is a real timesaver to prepare a few tennis balls in advance.

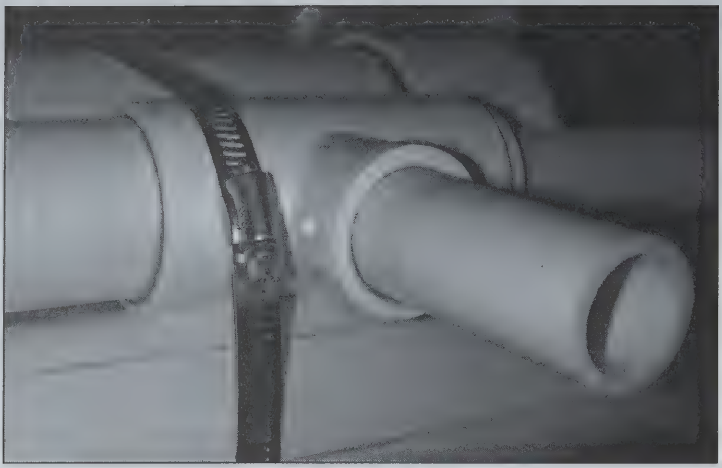
A standard tennis ball weighs 2 ounces, and this is not always enough weight to pull the line down against the friction presented by the tree branches. The weighted balls have two advantages. One is the improvement in pulling the line down. The other is a slightly slower trajectory for the same height, which can help with line breakage if that is a problem.

You should always use as little additional weight as necessary for safety reasons. I have added up to 6 oz of lead shot by slitting the ball and working a small plastic bag holding the lead inside the ball. Although I haven't tried it, sand should also work, though the ball will fill up at a lower weight. Experiment.

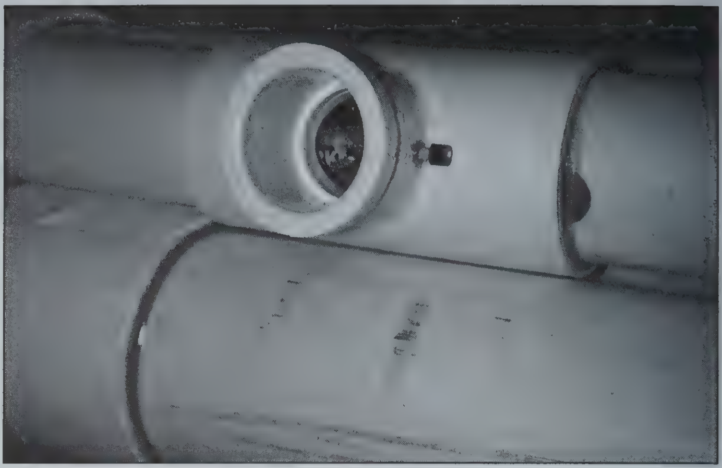
My plan is to have several different ball weights and use the lightest that will accomplish the objective. Two, four, and eight ounce balls will be in my kit next Field Day. Perhaps a four ounce ball (two ounces of added weight) will be about optimal, but only more field testing will tell.

System Calibration

I have measured performance data on this model with a chronograph (measures velocity). The following table shows approximate trajectory peak height in feet for launch pressures from 50 to 80 pounds



Front handle and main clamp.



Inside the trigger switch handle.

per square inch, and even ball weights of 2 to 8 ounces. It was determined by measuring the velocity and computing the height based on a simple drag model. There are many sources of variation, so these numbers are only approximate.

Peak Height in Feet:

Pressure (psi)	Ball weight (oz.) 2	4	6	8
50	40	80	80	70
60	80	160	120	110
70	140	200	160	150
80	190	230	190	180

The Launcher can be pressurized with any air pump capable of the pressure—electric 12 VDC automotive tire pumps are excellent, and a hand or foot pump works also. This design requires about 40 psi to start working, and the useful pressure range is from about 50 to 80 psi.

The first time out, characterize the pressure performance of the system. Start at 30 psi and go up in 10 pound increments. Launch in a clear area next to some trees to help gauge the height. The ball won't bounce much if you cut a slice in it to relieve the pressure. *Caution*—don't use more pressure than needed to achieve the desired objective, and don't exceed the planned operating pressure. The line paid out during the launch can be measured to determine accurately the height of the launch.

A version of the modeling software I developed for Pneumatic Launchers is available on my website (link below). This model computes velocity and height for various pressures given physical data about the system such as volumes, bore length and system flow capacity. If you have access to a chronograph a measurement of the velocity can be used to calibrate the system flow coefficient. Detailed velocity and height tables can be prepared for different ball weights. See the website for further details.

Using the Antenna Launching System—

1. Preparing for Launch—Choosing the Path and Landing Area

The most successful launches are usually those that are well planned. Consider which direction(s) are available to launch in. In some cases the safety of the landing area determines the direction of the launch. Other issues to consider include which direction the line needs to go, and how much room there is for the landing. I usually plan my launches to pull monofilament over, then nylon twine back, and last either the wire antenna, or a heavier line to support a beam or longer wire. The plan followed above, launch over several trees, pull twine back, pull wire antenna up into inverted L, is one of the quickest and easiest to execute in one launch. Make certain the landing area is clear and safe, and that an overshoot will also be safe—these things have a way of going further than planned, especially if the line breaks.

2. Choosing ball weight

The 2 oz. balls fly fast and high, and are the safest, but the friction may make recovery on the far side of the tree difficult if the ball won't pull the line down. The 4 oz. models fly about 30% slower for the same height, and come down a bit harder. Balls heavier than 4 oz. don't go as high (4 oz. is about optimal) and land increasingly hard. Use a ball heavy enough to pull the line down, but no more.

3. Loading

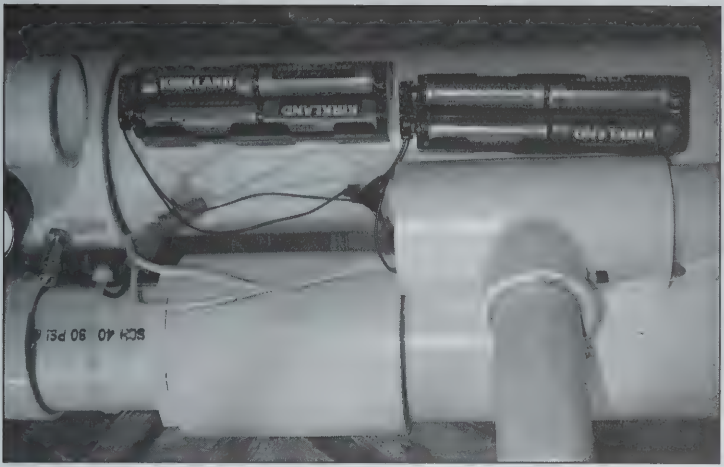
The reel should be positioned slightly beyond the muzzle of the bore. The reel oscillates as the line is reeled in to spread the coils, so position it to the most forward position for optimal clearance. Tie a large loop into the end of the line, large enough to slip the tennis ball through. Slip the line loop through the ball loop, and then around the ball. Push the ball into the bore until flush with the muzzle, just to hold it while setting up the reel. Set the drag on the reel to near zero, just a slight tension on the line. Take up any slack by rotating the reel spool by hand. Push the ball all the way in —the reel should feed out line as it goes. Open the bail on the reel. Make sure this step is not skipped!

4. Pressurizing

Keep the muzzle pointed in a safe direction. Refer to the chart to select the desired pressure. Be very careful if using an electric compressor—don't get distracted and let the pressure climb too high! Eric, WD6CMU uses a gel cell battery (such as a 12V 7AH) and portable 12 volt automotive type compressor so he can carry it in the field to right where he is launching—very convenient!

5. Observers

It helps to have one or two observers who can watch the trajectory of the ball, especially in the landing area. They should be positioned in a safe place such as off to



Electrical wiring and batteries.

Tennis balls, tools and weights.

the sides of the intended path. Safety glasses and hard hats are recommended.

6. Safety

Eye protection should be worn for safety. Point the muzzle in a safe direction at all times (up, downrange).

Perform a final check: Check the open bail and line position. Check the pressure. Look downrange and insure it is clear. Check that the observers are ready. Let them know you are about to launch.

Take aim. Hold the launcher firmly—there is modest recoil, especially with the weighted balls, and follow-through—it takes a noticeable time for the ball to eject. If you don't follow-through you may miss your spot. Countdown and launch—everyone should know when it is launching, and should keep a watch in case the ball bounces off the tree in an unplanned direction.

Once the line is over the tree(s), locate the end and remove the tennis ball from the end. Tie the end of a roll of nylon construction twine to the monofilament and reel it back over the tree(s). If a heavier line is needed, pull it with the twine, but for short-term wires the twine can be used to support (most) wires directly.

7. Problems

Occasionally there are problems with line breakage. Generally this is caused by forgetting to release the reel, or the line snagging on something. Using a shock absorbing leader or a few feet of much stronger line for the leader may help, though we have not resorted to that yet. One thing to consider is where the line will part if it gets stuck and you have to break it off. It is probably desirable to have it break near the ball rather than down in the middle of the line somewhere. Usually the knot near the ball in the monofilament will break first.

Wind causes a couple of problems. It doesn't affect the weighted ball too much, but the line gets blown around. You can sometimes take advantage of it, while at other times it can drift the line away from the tree before it drops into place.

Variations and Improvements

Pressure safety valves are available that will release the pressure if it reaches an unsafe level. This would be a good safety improvement, especially if an electric compressor is used to fill the chamber. Be sure to select a pressure relief valve which is large enough to handle all of the compressor's flow.

The barrel and chamber length are approximately the minimum to get adequate performance for antenna launching. Making these longer will increase performance or allow the same performance at lower pressure, which provides increased safety.

The trigger in this prototype unit does not have a trigger guard or safety switch. Adding both of these items would be a wise improvement. Also, a mercury switch could be installed in series that would only allow launching upward. A second pushbutton in series would require both to be pushed to launch, keeping that free hand out of danger.

Pneumatic triggering would open the valve faster, increasing the flow into the bore. It replaces the batteries, switch and solenoid with a hose and manual valve. Eric's design works this way. Details can be found on the Internet.

Shielding the pressure chamber to contain possible PVC shrapnel in the case of a failure might be a worthwhile safety improvement. Tape, cloth, mylar, nylon or wire mesh, etc. might be employed.

Safety and Legal issues

There are several safety and legal issues that need to be considered in this project. There is considerable energy stored in the compressed air; it is important that it not be released in an unintended manner. Read the preparation, gluing, and curing instructions carefully and *follow them*. Use only *new PVC* and *cement*, and don't use any material which is obviously yellowed, scraped, cracked, or weathered. Proof testing is prudent, and repeating it periodically is a good idea. If the unit is ever subjected to dropping, severe shock, extended sunlight, chemicals or other conditions known or suspected to be damaging to PVC, or any flaws in the material become visible, then immediately *replace* the questionable components.

WARNING—while the schedule 40 PVC pipe I used is rated at 260 psi or better operating pressure, the manufacturers DO NOT recommend it for use with compressed air (remember, this is water pipe). If it fractures under pressure *PVC shrapnel* may result. Also, PVC may fracture if dropped or hit by a hard object. If you choose to build one of these *you* must take responsibility for safety.

Legal issues are another matter. The U.S. Government BATF (Bureau of Alcohol, Tobacco, and Firearms) has ruled that compressed air launchers are not

firearms, and so they are not regulated by firearms law. Pneumatic launchers are used commercially for many purposes, including launching T-shirts at games, explosive charges for avalanche control and they are common high school science projects. Remember, the velocity of this launcher is similar to velocities achieved on a tennis court with a tennis racket, but remember that the weighted balls have considerably more momentum.

There are other types of launchers that use fuel combustion (such as lighter fluid, propane or hairspray), and they are often used to shoot vegetables (potatoes, apples, etc). The combustion systems are less predictable and not as safe or well suited to line launching for antenna installation.

Local municipalities may also have rules about the use of some types of these systems, so do some research. Whatever you choose to do, make sure you do it in a safe and responsible manner. Always wear eye protection, use the minimum ball weight, minimum chamber pressure, and insure that the area is clear before launching...and *never* point the launcher at any person.

It is best to do initial testing in a wide-open space to learn the performance parameters. We primarily deploy them in National Forest lands where there is plenty of room. Work pressures up gradually to avoid being surprised.

Note that other launching systems are generally more regulated—archery and slingshots are illegal to use in many or most municipalities, for example.

Neither *QRP Quarterly* nor the author is responsible for any injury or damage resulting from anything you choose to do. You are wholly responsible for safety and legality.

Future Plans

I am working on a couple of different new designs for antenna launchers. The goal is to reduce the size and weight of the system even further. Unfortunately this seems to require using more exotic parts that are both harder to obtain and more expensive. The design described in this article represents a good balance of performance, size, weight, cost and availability of components. It is very effective, and also a lot of fun. Refer to my website (url listed below) for updated information.

Safe Launching!

Thanks to John Bercovitz, Eric Williams WD6CMU, Dawn Biocca KB6LHP for help in preparing this article. Photos by the author and Dawn KB6LHP.

Parts List for the TBL-U37A

- Electric sprinkler U valve, 1" fpt (female threaded), 24V, Rainbird model DAS/ASVF-100—There is another Rainbird model that has a piston valve instead of the diaphragm valve in this model. The performance of the piston valve has not been tested by the author.
- 1" diameter by 1.5" short threaded pipe, brass or iron, 2 each—all pipe threads in this project are NPT (National Pipe Thread) tapered 1" or 1/8"

Note: All PVC pipe and fittings must be pressure rated schedule 40!!! Schedule 40 is always marked as such. Accept no substitutes and DO NOT use anything but schedule 40 pipe! This is a safety issue.

- 1.5" slip x 1" fpt (female threaded) PVC adapter bushings, 2 each
- 3" slip to 1.5" slip PVC adapter bushing
- 3" slip-slip PVC coupler
- 3" by 24" long schedule 40 PVC pipe long (main pressure chamber)
- 3" slip PVC end cap
- 2" slip to 1.5" slip PVC adapter bushing
- 2" by 4.75" long schedule 40 PVC pipe (expansion chamber)
- 2.5" slip to 2" slip PVC adapter bushing
- 2.5" slip to slip PVC coupler
- 2.5" by 21" long schedule 40 PVC (barrel)
- 1.5" slip x 1.5" slip x 1" slip PVC reducing Tees, 2 each (1" port on the side)
- 1.5" slip x 1" slip PVC adapter bushing (reel mount adapter)
- 1.5" by 25" long schedule 40 PVC pipe, cut to:
  - 10" sight tube
  - Approx. 8-9" main handle center tube and battery compartment (fitted)
- 4" rear battery cover
- 1" by 15" long schedule 40 PVC pipe, cut to:
  - 6" reel mount
  - 4" handles, 2 each
  - 3/4" by 24" long schedule 40 PVC pipe (ramrod)
- *Fresh* PVC primer and glue with applicators (small 2 oz. cans adequate)
- Schrader Valve, 1/8" NPT thread (fill valve)
- Pressure Gauge, 160 psi, 1/8" NPT (chamber pressure)
- Two each 8-AA battery holders, approx. 1" by 1" by 7", Radio shack model 270-407A
- Two each 9V battery connectors, Radio Shack model 270-324
- Small momentary pushbutton switch rated 0.5A 30VDC or better, such as Radio Shack 275-1547 or 275-1549 or similar (trigger)
- Two medium wirenuts
- 12" tie wrap
- 16 gauge wire, approx. 24"
- 4-1/8 to 7" diameter hose clamp, stainless steel (main clamp)
- 1-1/16 to 2" diameter hose clamp, stainless steel, 2 each (reel holders)
- Small block of wood, approximately 0.5" x 1.5" x 3.5" (separator block)(fitted)
- Fishing reel, large spinning or closed face casting type, with 200+ yards 15-20 pound monofilament line
- Tennis balls, 3+ as needed
- Lead shot or sand to add weight, up to 6 oz. each (optional)
- Plastic bags, sandwich type, to hold shot/sand (optional)
- Misc—epoxy, electrical tape, Teflon® plumbing tape, solder, heavy thread, 16 each AA batteries
- Tools—saw, file, sandpaper, drill and bits, small soldering iron, 1/8 NPT tap, heavy needle, utility knife, latex gloves
- Safety glasses!

Related Web Links

1. ARRL Field Day 2002 WN6I photos including Big Bertha Launcher and Big Slingshot: http://www.arrl.org/contests/soapbox/index.html?con_id=13&call=wn6i (or go to the ARRL 2002 Field Day website and search for WN6I)
2. Rainbird Valve: http://www.rainbird.com/pdf/diy/DAS_ASVF.pdf and http://www.rainbird.com/diy/products/valves/das_asvf.htm
3. PVC fitting supplier: http://www.plumbingwarehouse.com/pvc.html
4. Component supplier: McMaster-Carr; http://www.mcmaster.com/
5. Eric WD6CMU's web (home of Big Bertha): http://www.qsl.net/wd6cmu/
6. A commercial site with similar devices, and a source for components: http://www.spudtech.com/
7. Author's website—modeling software, updates: http://www.qsl.net/wb6zqz/

My New 40 Meter Antenna

Joel Denison—KE1LA

hamjoel@juno.com

Special Antenna Edition
Ramblings of a Displaced Cajun Lad

High Y'all!

I going to do my best to write this in English for you. It's about my new antenna. I have a couple of trees in my yard with almost enough distance between them to string up an eighty meter dipole between the two, if I pull the wire into the branches and near the trunk of the tree.

The reason I chose 40 meters is because that is where the QRP action is, and I do NCS for the FP (Flying Pigs) Wednesday nite net on 40 CW at 8 p.m. Eastern, on or about 7.044 MHz. Basically what I've done is put Cajun logic into the project...

First I took two half wave dipoles for forty meters (each 66 feet long) and put them side by side like two half waves in phase. I used a small egg insulator in the middle to separate the two, and then feed that with 300 ohm twin lead with 66 feet of wire each side of the insulator—basically an 80 meter dipole or (Cajun logic) two half waves in phase on forty meters...

I pulled that into the air and into the trees, and I was able to flattop it about 40+ feet above the ground and about twenty feet or so above the roof of my house. With it in the air like that, I worked Australia and Hawaii, SSB on the triple H net about three in the morning Eastern time, at 5 watts. Those guys have respect for QRP, 'cause in two nites I worked two DX stations some of the QRO guys couldn't reach.

Looking up at the antenna I decided it needed an extra element...hmmm...how about a director...That's only fourteen feet spacing on forty meters (.1 wave), so I went down to the hardware store and bought two fourteen foot closet rods (big dowel rods) to use for spacing the antennas elements. (Later I found I really needed three to keep the center from closing in on itself).

I then figured the director should be about 6% shorter than the driven, and after much reading and consulting, finally decided on 62 feet as the right size. The size difference between the two elements, director and driven elements, is four feet, so I used some rope to space the director two feet off center and added two feet of rope at the ends so the total length of the elements was the same 66 feet.

Now I had two directors centered in front of two driven elements on forty meters, however it was still on the ground and the ground here is frozen...and so is the air....

I made a bridle for the dowel rods from a 28 foot piece of rope, made a small loop in the rope at the half way point, and tied the ends of each side of the rope to the ends of the dowel rods—an equilateral triangle of 14 feet on each side...excellent...then I tied the wires to the dowel and got out the rod and reel and got some rope into the trees...

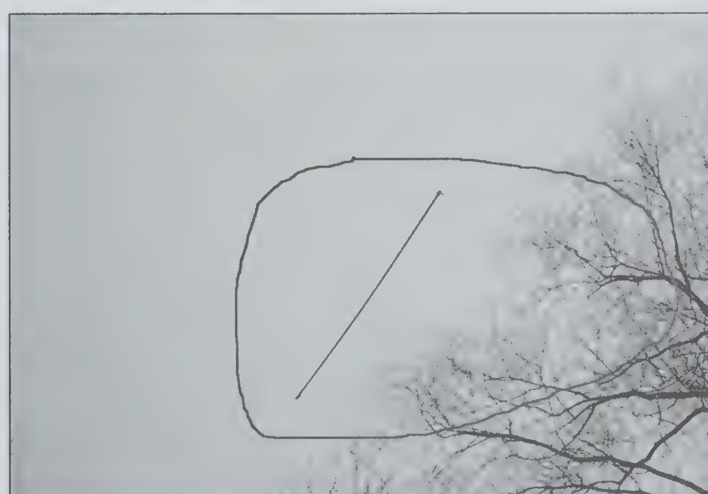
It was then I found out I needed to make the antenna only about 60 feet on each side, so I adjusted where I tied the wire to the dowels and just let the excess wire hang down. I pulled the dowels, now attached to the wires, into the trees and was able to reach a height of about 30 feet, or almost to the top of my roof. It was then I noticed I could use a dowel rod in the center to keep it at the fourteen foot spacing. Having no money for another dowel rod, I tied a piece of rope to the director and a tree and tightened to achieve a fourteen foot spacing...or so...

So now I have two two-element yagis, side by side, and almost 30 feet high. When the wind and cold moderate to about 20 degrees Farenheit and less than gale force, I will shorten the antenna a bit more and add the center dowel to keep the spacing right (and haul it back up...hopefully higher).

I'm using braided nylon (Wal-Mart special) rope with a working weight of 74 pounds, and so far it's held up in this most recent four day gale force wind—and I don't expect any problems. The antenna is pointed a bit more North than I would like, however the only other available tree is across the street and I haven't figured out a plan to get to it yet. I'm working on it...

And that's the new antenna. I hope this answers lots of your questions, and I do apologize for the plain English translation.... Bye now,

—Joel up in Maine



Here are the two ends of my new antenna. I've circled the spacers that go between the driven elements and directors.

A Differential-T Antenna Tuner

Mike Branca—W3IRZ w3irz@att.net

The purpose of an antenna tuner—or its synonyms: antenna coupler, antenna coupling unit, transmatch, antenna tuning unit, etc.—is to match the transmitter impedance (usually 50 ohms resistive, or non-reactive) to whatever impedance is present at the transmitter end of the feed (transmission) line.

Generally, in home stations where there enough room to get at least 1/4 wavelength of wire for the antenna, the impedance will be over 50 ohms and reactive (either, capacitive or inductive). For mobile stations that normally use less than 1/4 wavelength antennas the impedance is usually less than 50 ohms and reactive.

The operative word here is "usually" because the feedline characteristics can change all of the above. If we wanted to, we could buy a lot of equipment and spend a lot of time measuring these impedances—which happen to be frequency dependent, by the way. We could then produce page after page of very interesting charts and curves to impress our friends. To use this data, we would then use a lot of math to calculate the values of capacitance and inductance required to match a particular antenna on a particular frequency. We would then have to build all of these networks before we could use the antenna.

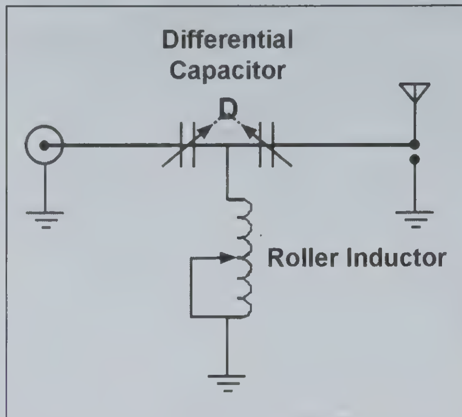


Figure 1—Schematic of a differential-T impedance matching network.

In reality you couldn't care less what the antenna impedance is. That's right—who cares? You simply twist a couple of knobs on your antenna tuner to get the match then go on the air. It's done empirically; no math needed.

Although I have used many antennas over the years and fed many with coaxial transmission lines, I personally don't feel comfortable unless I can see a tuner and open wire line in my ham shack. To me it just doesn't look right without them.

My purpose in this article is to encourage newcomers to try to build an antenna tuner and to give enough tips so that it will work perfect the first time. I probably have built more tuners that didn't work to my satisfaction than those that did. The beauty of the matter is that you simply disassemble the ones that don't work and use the parts on the next project. But, most people don't need a lot of failures when they are getting started in something. With these tips, if you decide to purchase a factory built unit you will at least know what to expect before you buy and use it.

In this project, you'll notice that tapped coils and plug-in coils have been replaced with an infinitely variable roller inductor. The reason is that by using a roller induc-

What is a Differential Capacitor?

Differential capacitors serve a specific function in matching, just as ganged capacitors serve a specific function in superhet tracking. A differential capacitor is a dual capacitor in which one side meshes as the other side unmeshes—when one side is fully meshed the other side is fully unmeshed. At mid-scale both sides are at half-mesh. The simplest way to make a differential capacitor is to gang two identical capacitors 180 degrees out of phase. To do this you either need capacitors with shafts coming out of both ends or you can use gears or cords and pulleys.

I have tried both methods, however, there are two negatives to this approach in addition to the obvious mechanical ones. First is the large size or bulk (requiring a larger cabinet) and the second is the larger capacitance to ground (chassis) that this bulk presents. Since the capacitor floats above ground in the usual "T" circuit, too much stray capacitance could wipe out the ability to tune 10 and 15 meters.

Most of you are familiar with the popular Johnson Matchboxes, which used two differential capacitors in their design.

Figure A—Differential capacitor construction.

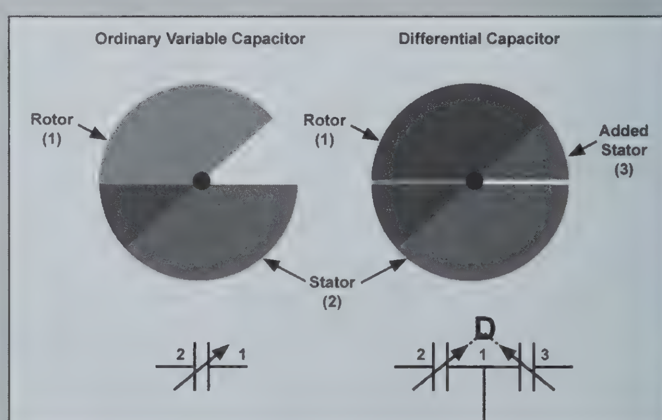


Figure B—Ordinary vs. differential capacitor.

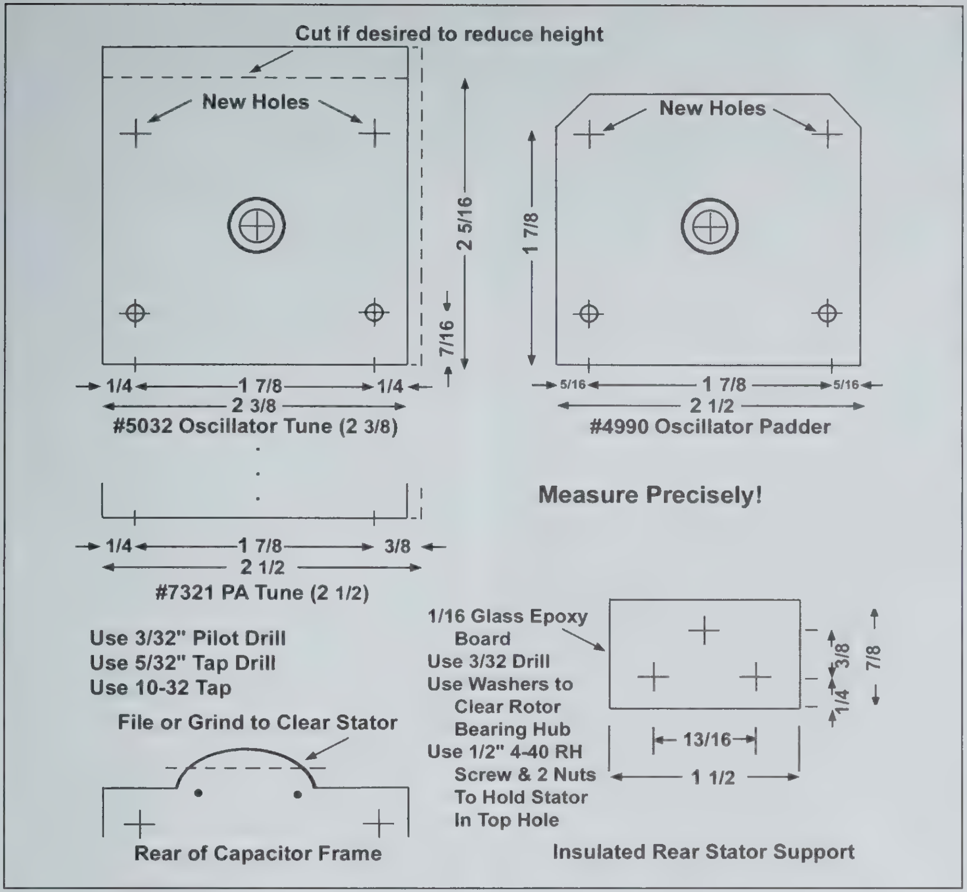


Figure 2—Converting ARC-5 capacitors to differential capacitors.

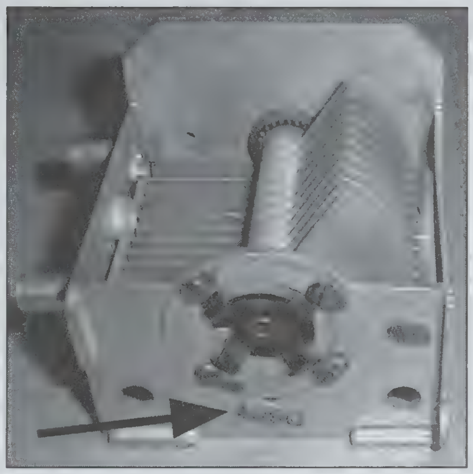


Figure 3—ARC5 capacitor labeling.

tor it is easier to get a perfect match. My experience with tapped inductors is that you can never get enough taps. Once you get it set for one antenna it is OK but if you change antennas you have to start over again with new taps. Evidence of this can be found in the ads for the commercial designs that advertise up to 47 taps. The late Lew McCoy, W1ICP was the pioneer who came up with the idea of a universal transmatch where one circuit would be flexible enough to handle all loads. He called this the "Ultimate" circuit and introduced it in 1976.

Over the years, it has evolved considerably into the basic "T" network (see Figure 1). Although I made experimental tuners using a differential capacitor in Lew's original transmatch design in the 1970s, I don't know who the first ham to try the differential capacitor in the "T" network. But, I have experimented with them in this circuit since the early 1990s and have learned to like them. The best reason to use a differential capacitor in a tuner is to reduce the knob count to two (one for the inductor, one for the capacitor). This increases the speed in tuning considerably, which facilitates band hopping.

How to Make a Differential Capacitor

The following serve as examples of how the construction process could be. The capacitors that you are able to find will determine the direction that you should take. Some of these capacitors are more than 60 years old and may not be available at every hamfest you go to, but I never have been to a hamfest that did not have usable capacitors. For some capacitors you will have to work out your own details.

These tuners are designed for the 100 watt level as a lot of us like to be able to raise power when conditions (such as maintaining a schedule) require it. Reasonably priced transmitting variable capacitors for this power level don't seem to exist except in surplus. Trying to make differential capacitors from receiving capacitors is much more difficult than from transmitting capacitors. I have five designs that I have worked out. The first three are shown in Figure 2 and use "Command Set" (ARC-5) capacitors. These capacitors are labeled as shown in Figure 3, indicating their use in the ARC-5: Oscillator Padder (#4990), Oscillator Tune (#5032) or PA Tune (#7321). In every hamfest that I have been to in Maryland, Virginia, Ohio, North Carolina and Georgia I have seen (and purchased) these capacitors.

To use these capacitors to make a differential capacitor, all you have to do is take two capacitors of the same kind, remove the stator, pyrex glass balls, and adjustment screws from one capacitor, invert and mount this new stator over the existing stator in the other capacitor. Two new holes have to be drilled precisely in the frame and tapped for the stator adjustment screws. The rear of the stator is supported by the 1/16" glass PC board and three screws as shown in the sketch. Do not rush the stator alignment. The model using the Oscillator Padder (#4990) will have 175/20-20/175 pF. The models using the tune capacitors (#5032 & #7321) will have 150/20-20/150 pF and a slightly greater spacing.

If you are contemplating 160 meters you might want a 200/20-20/200 pF capacitor. You make this by taking the rotor from the PA padder capacitor #7324 and installing this in the tune frame (#5032 or #7321). The PA padder (#7324) is the one that is too short in height to make into a differential capacitor but can supply the rotor, stator, glass balls and stator adjustment screws. This takes a lot of patience because of all the little ball bearings. Do the disassembly and assembly over a cigar box or shoe box to catch the balls and use Lubriplate or Vaseline to glue them back one at a time.

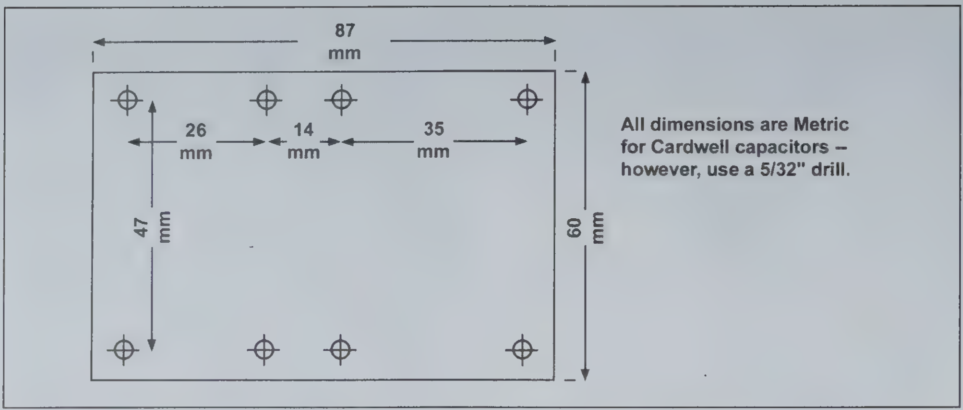


Figure 4—Converting Cardwell capacitors to differential capacitors.

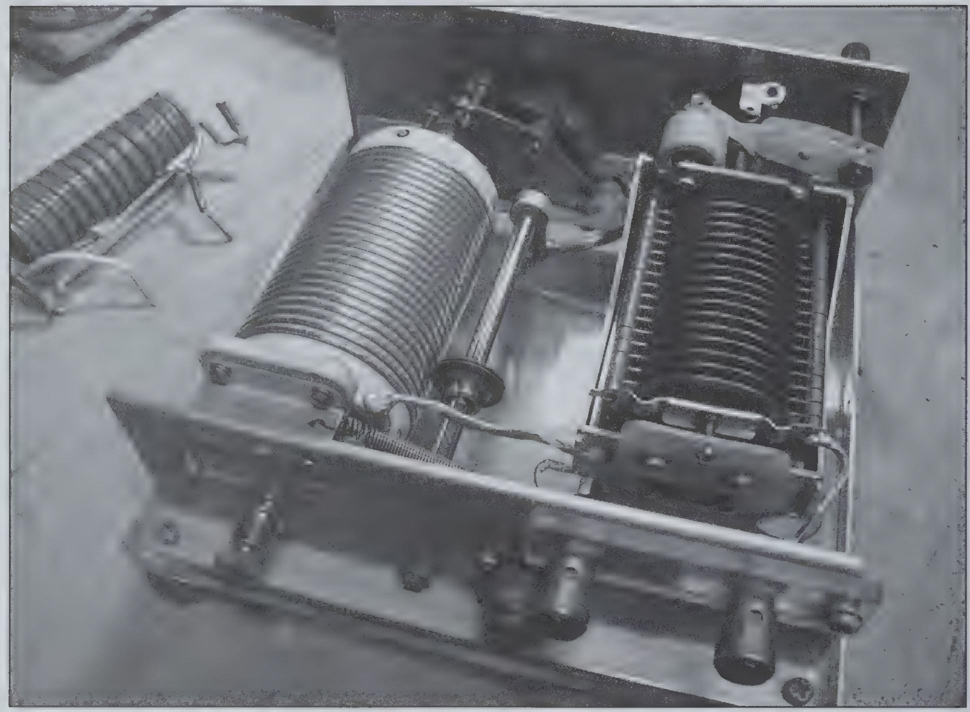


Figure 5—Internal view of the differential-T tuner.

The fourth capacitor design can be made from two Cardwell 175 pF capacitors (from the T-195 transmitter). Simply take 1/16" pc glass board and mount the extra stator over the rotor per the sketch (Figure 4). Again be sure to take the time necessary for proper alignment.

The fifth design uses the BC-375 tuning unit capacitors that show up so frequently at hamfests. This may be the easiest one to make but the largest capacitance seems to be about 165 pF which may be marginal at 80 meters. Anyway, the extra stator is mounted to a scrap of 1/16" glass PC board by drilling and tapping the ends of the original mounting rods for 4-40 screws. This assembly is then mounted on another larger (3.5" x 4.5") piece of pc board (or dry wood like I did) using pieces of 1/16 board as spacers. The complete remaining capacitor with its ceramic mounting spacers will now straddle the new stator. This new stator mounted on the wood block should be connected on the coax side of the tuner. There is generally a lower RF potential there. The sketch and the photo will make the assembly clear.

Construction and Use

The roller inductor and differential capacitor can be laid out side by side, as shown in Figure 5. If you use a metal cabinet, the entire capacitor should be insulated from ground (using strips of wood, phenolic board or Plexiglas) since both stators and the rotor "float" above ground.

An insulated coupling or insulated shaft should be used to isolate the frame and shaft from hand capacity since the circuit requires a "hot frame." A large knob greater than 2.5 inches in diameter usually can also be used but moving your hand near the front of the knob can affect the tuning.

The roller inductor used in these tuners should measure at least 25 μH if you intend to use the tuner on 160 meters. One of the more popular inductors is the one made by E.F. Johnson, #229-203. These should be set up with some kind of indicator to record the turns count as you change bands. There are many different types of roller inductors found at hamfests and a future article will show how to set them up and how to make some turns counting dials.

In use be sure to do your initial tune up at low power to get a perfect match. This will usually be close when you increase your power. The reason for this is that the final amplifier when operating at low power is operating at a mismatch between the transistors (or tubes) and its 50 ohm matching circuit that is designed for full power. This low power mismatch is being compensated for by the antenna coupler. Switching to full power removes this mismatch and requires some retuning but this seems in my experience to be less so than with modern solid state transmitters.

The key to rapid band changing is to create a tuning chart for each of your antennas on each band. This should be effortless because after you build or buy an antenna tuner you are going to check it out anyway. Simply jot down on a piece of paper (or 3" x 5" card or back of a QSL card) the settings of the knobs on each band. Obviously you need calibrated dials for this and simple 0-10 scales are fine.

When tuning up you will note that one of the knobs tunes more sharply than the others. Each band may have a different critical tuning knob. On your chart simply put an asterisk next to the sharp tuning value for each band. Now that the chart is complete band changes are very easy, simply prescription set per your chart and when you QSY in the band use the knob with the asterisk for that band. This will change somewhat with the seasons and the weather but is a good guide. I can usually make a 9 band tuning chart in around 15 minutes. This is such a simple step and takes so little time so be sure to do it.

The Nursing Home Loop

Dick Arnold—AF8X AF8X@comcast.net

This past summer I installed a Carolina Windom across my yard with the vertical part of the feed line dropping near the edge of my roof and about midway along the back of my deck. My XYL objected to that "ugly wire" hanging over her head and so, to keep peace in the family, I spent $1100.00 on an awning to cover the deck and hide that "ugly wire" from view.

I also opted to take down my other wire antennas and my vertical to gain even more favor from the XYL, thinking the Windom would cover everything I needed. Well the Windom is a fine antenna, but I have three radios and switching the antenna from one to the other got to be too much fuss, besides I sometimes like to have two radios on at then same time on different bands. Also, the Windom needed to be grounded when not in use in case of electrical storms.

Photo 1—The loop runs around the perimeter of my 10 x 10 ft. ham shack at the top of the walls, near the ceiling.

My solution was an indoor antenna. I first thought of the attic, however, my house is a ranch style with very little room above the ceiling, so after some thought I came up with what my ham friends like to call (because of my age, I suppose) the Nursing Home Antenna. It consists of a length of wire stapled on top of the trim molding on the walls just a couple inches down from the ceiling. It's not too noticeable and when I find some paint the same color of the walls, it will be completely invisible (Photo 1).

My shack is a small ten-foot square room, so the total wire length was forty feet. The loop is fed at the center of one wall with 300-ohm TV wire, as shown in the circled area in Photo 2. It is terminated at my Elecraft K1 by connection to a BNC/dual binding post connector—detailed views are in Photos 3 and 4. The K1 loads perfectly on all four bands (15, 20, 30, 40) with the internal tuner and without a balun. I'm not worried about feedline radiation or loss, since the length of the 300 ohm feedline is quite short.

At first, I was doubtful about the performance of such a small antenna, especially being inside of a room. My fears were put to rest quickly, however, as my very first contacts on 15 meters were with stations in Italy and England! I have since worked Ireland, Germany, France, and a couple more Italian stations, besides making a number of stateside contacts—all using 5 watts. I was also pleasantly surprised at the reduced QRN on 40 meters using this antenna.

My friends were only teasing when they named this the Nursing Home Antenna, but it would certainly be an option for someone in a situation where erecting an outdoor antenna was prohibited. That includes a nursing home, of course, but this antenna could also be a good "stealth" alternative for condos, apartments or covenant-restricted homes. I think all hams like to experiment with antennas, and I have had many a bright idea crash and burn—but this one is a definite winner.

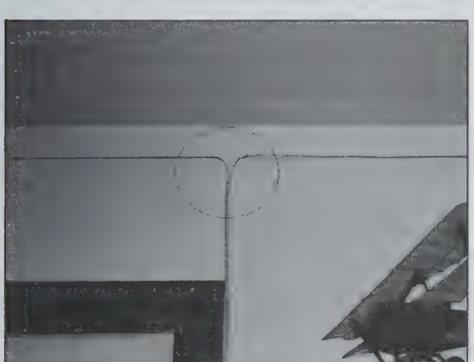


Photo 2—The feedpoint is located in the center of one wall.

Photo 3—The antenna is connected to the K1, which tunes it without a balun.

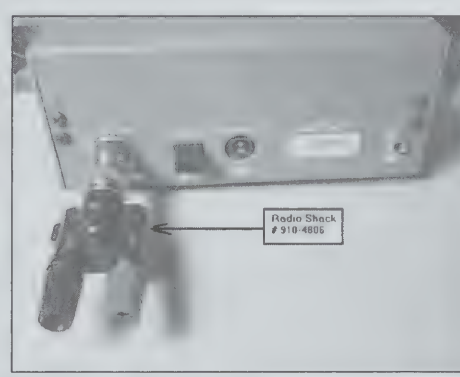


Photo 4—The connection is made with a binding post to BNC adapter.

A Photo Tour of FDIM 2001 & 2002

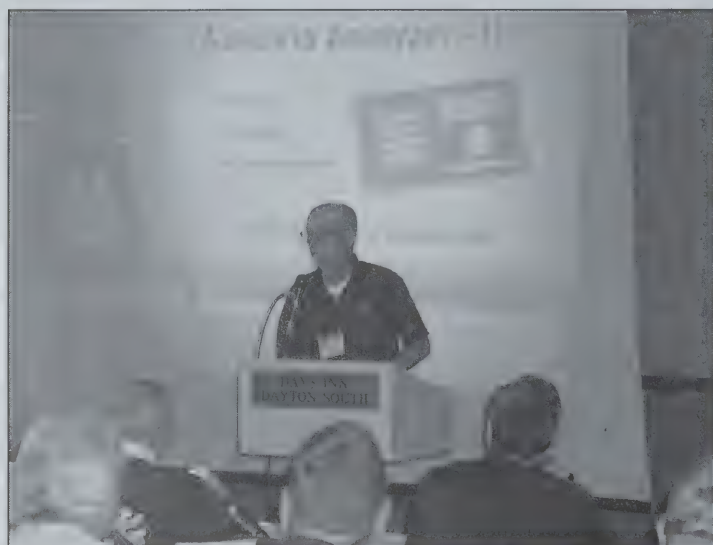
Four Days in May (FDIM)—the QRP Highlight of the Dayton Hamvention

To get your attitude "adjusted" for the upcoming 2003 FDIM (May 15-18, 2003), the *QRP Quarterly* staff presents a pictorial review of the 2002 edition of FDIM.

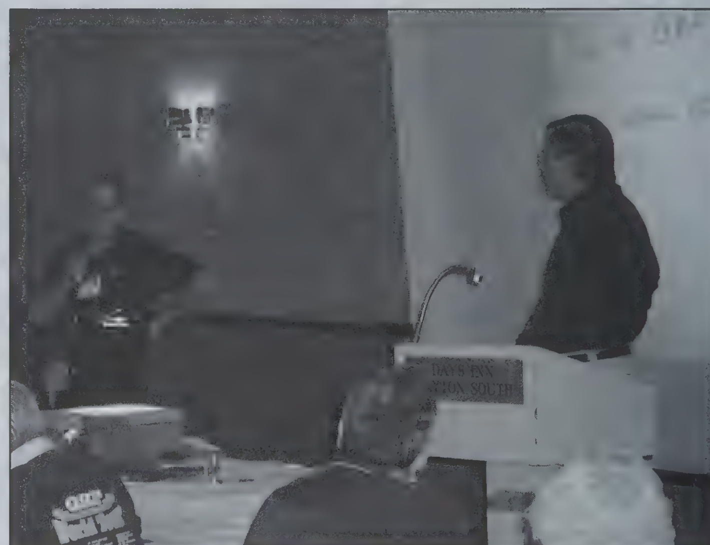
To say that FDIM is a major QRP event is an understatement—it is the #1 QRP event in the U.S., probably in the world. Where else can you hear about construction projects directly from the top QRP designers and builders? Where else can you mingle with hundreds of QRPers who are in your logbook from the many contests and operating events of the past year? Where else can you meet the legends of QRP and discover that they are happy to sit down and discuss *your* QRP experiments? Where else can you take your new ideas into the massive Dayton Hamvention flea market and find the parts you need—whether for a specific project or just to stock up your junk box?

Plan to make the trip to Dayton this May, so you don't miss an opportunity to learn, discuss, buy, sell and simply have fun with fellow QRP enthusiasts and QRP ARCI members.

There is nothing quite like FDIM!

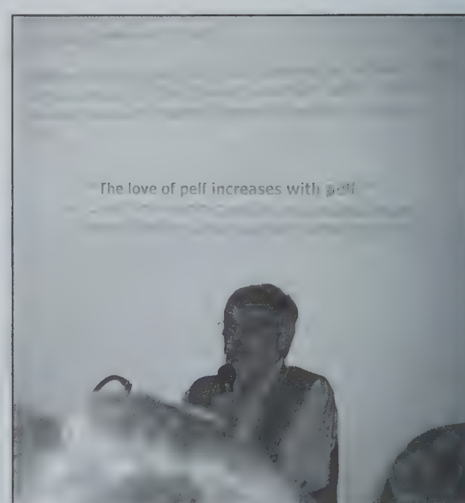


Tom Dooley, K4TJD opens the 2002 FDIM conference and introduces the first speakers. Under his direction, last year's FDIM was another great success.

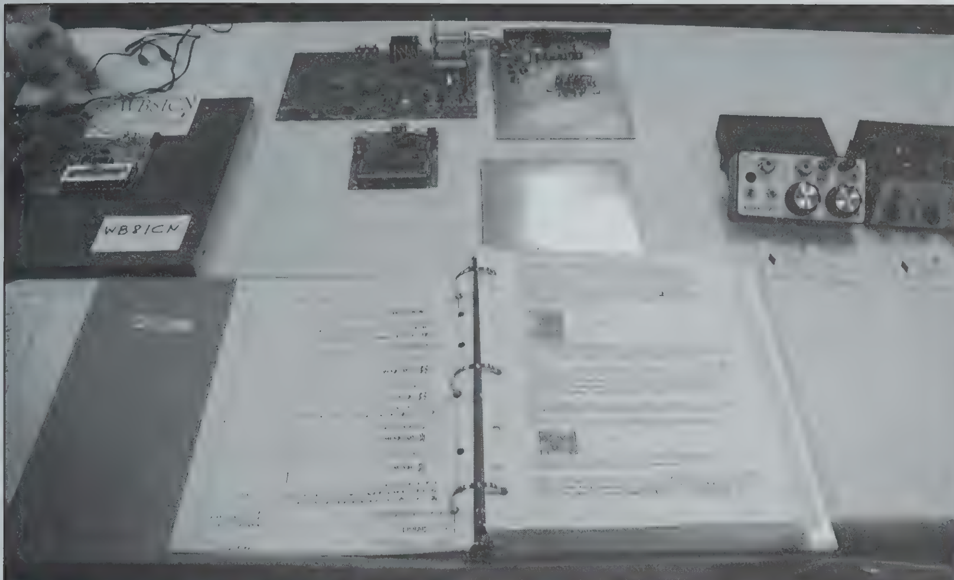


Joe Everhart, N2CX (left) and George Heron, N2APB (right) explain the ins and outs of the digital control portion of the NJQRP Antenna Analyzer project.

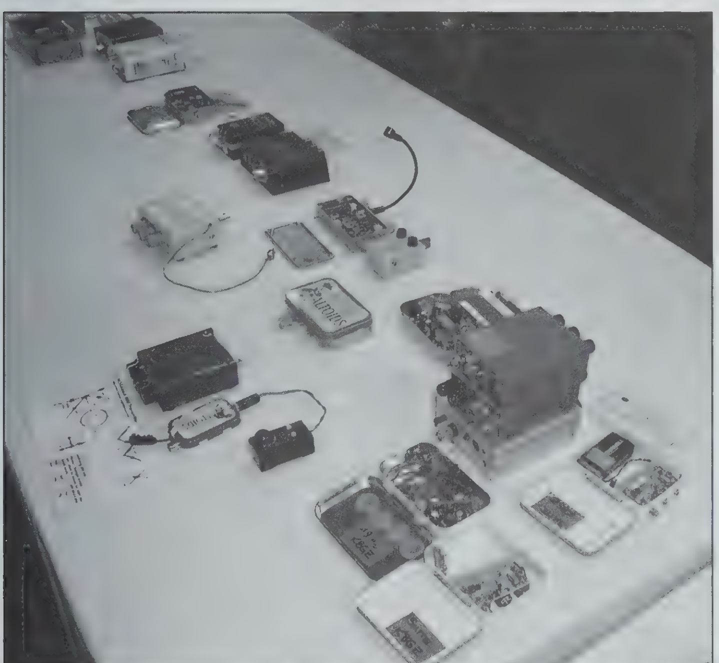
A full ballroom at the Dayton Ramada Inn South is evidence that QRP is alive and well. (And that the speakers are presenting interesting information!) The 2003 FDIM program lineup includes talks on antennas, weekend projects, radio rapair, a QRP transceiver and much more.



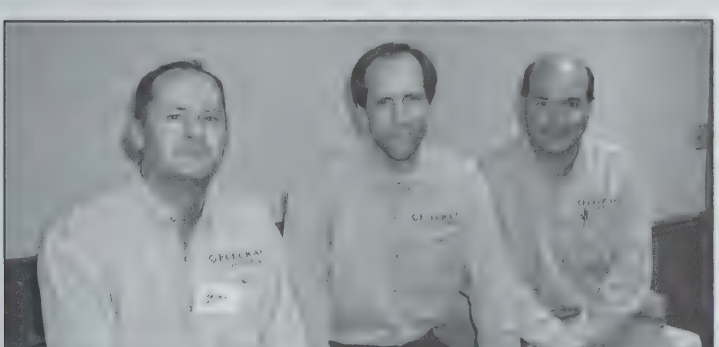
The Rev. George Dobbs, G3RJV, waxes philosophical as he introduces the QRP crowd to the concept of "pelf," or ill-gotten gains.



As these photos from FDIM 2001 attest, the QRP gathering at Dayton is the best place to show off your homebrewing skills, as a contest entry or simply as a project that you are proud of!



A table full of great projects. Look at all those Altoids boxes!



The Elecraft "brain trust" at FDIM 2001: Gary, AB7MY, Wayne, N6KR and Eric WB6HHQ.

FDIM 2003 Schedule

Thursday, May 15

8:15-4:00 p.m.—All-day FDIM Seminar; speakers are:
Rex Harper, W1REX and Darell Brehm
Stephen E. Brown, W9HC
George Dobbs, G3RJV
Peter Zenker, DL2FI
John Cumming, VE3JC
Jim Kortge, K8IQY
Mike Bryce, WB8VGE
5:00-8:00 p.m.—Flying Pigs/NOGA "Buildathon"
7:30-11:00 p.m.—Flying Pigs Test Equipment Clinic

Friday, May 16

Daytime—Dayton Hamvention exhibits and flea market
7:30-11:00 p.m.—Vendor Night and socializing

Saturday, May 17

Daytime—Dayton Hamvention exhibits and flea market
7:00 p.m.—QRP Recognition Banquet
8:00 p.m.—Design/Building Contest
All evening—Socializing

Sunday, May 18

Daytime—Dayton Hamvention exhibits and flea market
Travel home safely!

Full information on FDIM can be found on the QRP ARCI web site: www.qrparci.org

See You at FDIM!

Digital QRP Homebrewing

George Heron—N2APB n2apb@amsat.org

QRPers finally have their HC908 Daugtercards in hand and this issue's topic deals with creating special, custom programs with the easy-to-use Template program supplied with the project. We'll show how one can easily create a "Hello DDS" program to meet specific signal source needs on the bench. Then, our usual "second theme" for this column picks up with the fourth part of the PIC WX project—the PIC-based APRS Weather Station. Designer NKØE adds a wind speed indicator to his growing project using some clever techniques and a homebrew anemometer. We hope you enjoy the column this time!

—73, George N2APB

The Digital QRP Breadboard...Part 7: "Hello DDS and GPS"

The heart of the Breadboard project is the HC908 Daughtercard, providing 8 MHz of 8-bit computing horsepower with 32 kilobytes of flash memory, a built-in RS-232 serial port for loading new programs, and lots of I/O to control just about any QRP project we might need on our bench. This daughtercard has been long in becoming available, and all 300 of those who ordered the assembled and fully tested unit now have this little gem in their hands. I do appreciate everyone's patience and support along the way, and promise that you'll find the wait was worth it. In addition to being able to load and run all of the software programs described in previous issues of this column, we next embark on a journey guaranteed to excite the homebrewing hormones in your bloodstream.

"Hello DDS"

The first program one usually creates on a new platform is "Hello World!" This simple program merely displays a message to the console indicating that it is alive and that the assembly and download process works. As readers know, the HC908 Daughtercard already comes with a pre-loaded Monitor program (HCmon) that is controlled by a serial terminal, as well as a pre-loaded Exerciser program for the various I/O devices you might have hooked up. What we'll do next is create a new program called Hello DDS to show how easy and straightforward it is to use the built-in subroutines provided in the Exerciser to enable you to produce your own first program.

Figure 1—HC908 and DDS daughtercards controlled by a Palm PDA as a serial terminal for issuing commands and displaying messages.

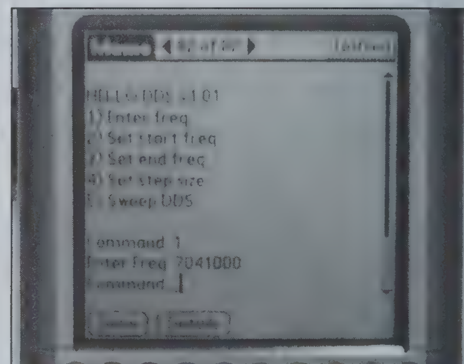


Figure 2—Close-up of the PDA screen prompting the user for frequency and scan parameters. (The simple Palm terminal application was written using Memo Pad "resources" (building blocks) to communicate with the HC908 Daughtercard.

Hello DDS is a simple terminal-driven program that prompts the user for the frequencies desired to be generated by the DDS Daughtercard connected to the HC908. As can be seen in Figure 1, the system is very easy to assemble. The "minimal breadboard" consists of the HC908 Daughtercard connected toan RS-232 serial terminal. I've used my PDA (a Palm Tungsten W) as the terminal, although you could use any terminal that has a serial port—e.g., a PC running HyperTerm, a Poqet Plus notebook computer running ProComm, or anything in between. Using a PDA is a convenience that allows me to more easily use projects when hamming out in the field or when on business trips.

The DDS Daughtercard is connected to the HC908 card using only three wires for the serial loading protocol and two wires for power and ground. (See the notes section at the end for details on this card.) A

9V battery powers both cards and the PDA terminal plugs into the HC908's built-in serial port. The schematic of this configuration is merely a simple subset of those published in previous issues of the column, and on the project's website, so it will not be repeated here.

When powered on or when reset, the HC908 card sends menu text to the PDA prompting the user for a command. As shown in Figure 2, he has a choice to:

1. Enter a freq—sends the specified frequency to the DDS chip
2. Set start freq—specifies the starting frequency for a sweep
3. Set end freq—specifies the ending frequency for a sweep
4. Set step size—specifies the step size to be used during the sweep
5. Sweep DDS—commands the sweep to begin

Creating "Hello DDS"

Now that you see what the end goal is, let's go through the process of actually creating the HC908 program that does this.

An experienced software developer knows that the best way to create a new program is to start by modifying an existing one. We'll use the Exerciser program as the starting point for nearly all our programs on the Digital Breadboard project, as it provides a convenient template for program format, interrupt processing, timing and access to commonly-used subroutines. To emphasize the value of this approach, I've provided a stripped-down version of the Exerciser program with the HC908 Daughtercard product itself, as well as on the Digital Breadboard website. (Recall that absolutely all software and hardware used in the Breadboard project is freely available for anyone's non-commercial use.) This Template.asm file is where all our edits will be done.

With no modifications, the Template program merely provides the interrupt hooks and common subroutines, as well as the interrupt structure for the heartbeat LED. This blinking LED on the HC908 card is a good indicator that your program is running satisfactorily (e.g., that it isn't hung up in an endless loop someplace.) If the Template program is downloaded to the HC908 card and run as-is, all you'd see is the blinking heartbeat LED with no other activity happening on the console, LCD, shaft encoder, DDS or anything. Try it and see! The main area of interest for us in the code is shown in Table 1.

```
User_Main:
        ldhx    #TemplateBanner_msg
        jsr     _puts               ;print the Banner message
 Main_Loop:
        sta     copctl              ;clear the COP counter
        bra     Main_Loop

TemplateBanner_msg:  fcb 'Template Program',CR,LF.0
```

Table 1—Portion of the Template program code that is our main interest.

```
1       User_Main:
2               ldhx    #DDSmenu_msg
3               jsr     _puts    ;print the Banner message
4       Main_Loop:
5               sta     copctl   ;clear the COP counter
6               ldhx    #Command_msg ;point to the 'Command' string
7               jsr     _puts    ;and print it to the terminal
8               jsr     _gets    ;get an input command
9               lda     _inbuf   ;get the entered character
10              cmp     #'1'     ;compare the input to '1'
11              beq     Set_Freq          ;if it was a '1', branch to
12                               ; the routine to set freq
13              bra     Main_Loop         ;go get another command
14
15      Set_Freq:
16              ldhx    #EnterFreq_msg ;point to the 'Enter Freq' string
17              jsr     _puts    ;and print it to the terminal
18              jsr     _gets    ;get a sting of numbers
19              jsr     Set_DDS           ;set the DDS output to that freq
20              bra     Main_Loop         ;and go get next command
21
22      DDSmenu_msg:
23              fcb     'HELLO DDS v1.01',CR,LF
24              fcb     '1) Enter freq',CR,LF
25              fcb     '2) Set start freq',CR.LF
26              fcb     '3) Set end freq',CR,LF
27              fcb     '4) Set step size',CR,LF
28              fcb     '5) Sweep DDS',CR,LF,0
29
30      Command_msg:
31              fcb     CR,LF,'Command: ',0
32
33      EnterFreq_msg:
34              fcb     CR,LF,'Enter Freq: ',0
```

Table 2—New code to be placed in the Template program.

What we'll do is place the new/modified program listing in Table 2 in its entirety with line numbers that we can reference to help explain the program operation.

The first thing we'll do is change the pointer to display a new set of text that represents the menu. Line 2 points to the new string to be output DDSmenu_msg at line 22. The call to the _puts (put string to console) routine then sends all the characters of those six 'fcb' lines to the terminal and only stops when it sees the '0' terminating character.

The program continues running at label

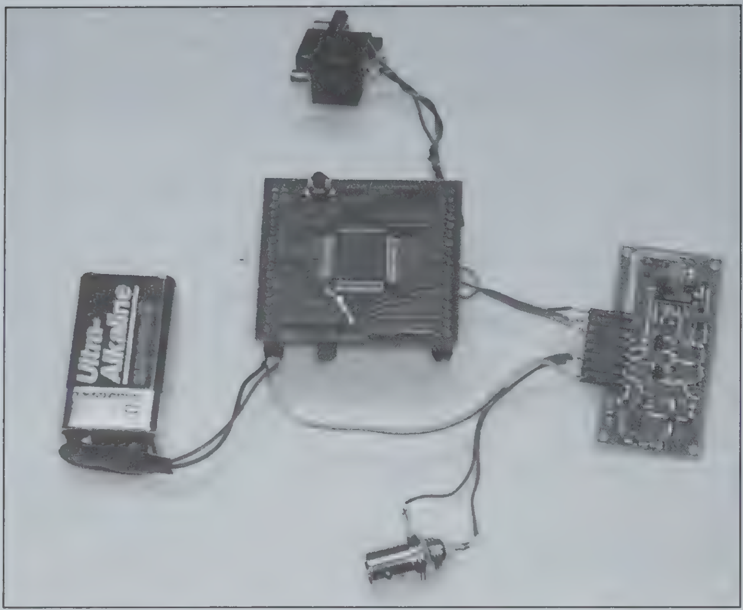


Figure 3—Close-up view of the straightforward HC908-DDS daughtercard connections.

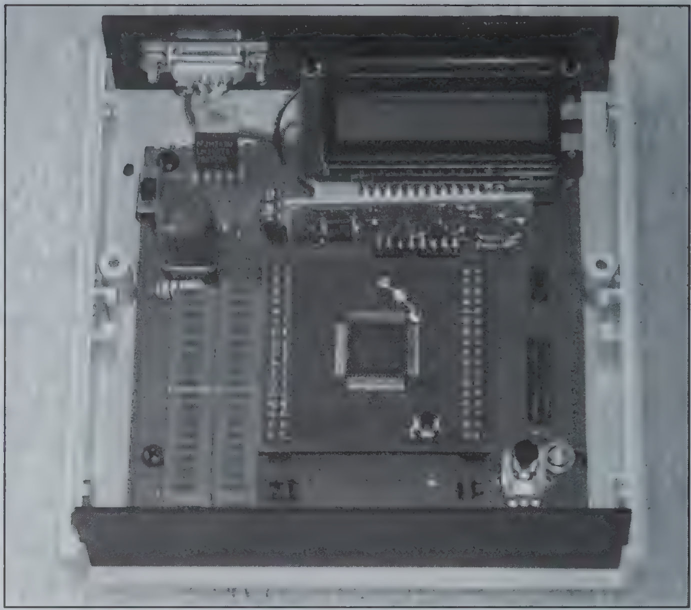


Figure 4—HC908 Test Fixture used to initially program and test all daughtercards produced.

Main_Loop (line 4), and accesses the copctl (Computer Operating Properly) control address, which resets the watchdog timer and prevents the program from automatically locking up.

Next, we added a couple of lines (6-7) to print the prompt 'Command: ', and added line 8 (jsr _gets) to get a user input string. (We won't do advanced things like range checking for valid entry.) The user input string is terminated when the <ENTER> is pressed.

Next we check the command character entered (located in '_inbuf') against the valid commands and branch to the appropriate desired routine when a match is found. (We'll only show one such command check. The full program listing at the end will show all command checks.) Lines 10-11 compare the input command to a '1', and if it was found to be a match, the Set_Freq routine is called. Otherwise, if no match was found, we instruct the computer to go back to the Main_Loop label and prompt for a command again.

Assuming a valid command was found ('1' in this limited case), the program execution jumps down to continue running at the label Set_Freq on line 15. The user is prompted for entry of a frequency string at lines 16-17 which displays a line of text at label Enter_Freq_msg, and the program waits at '_gets' (line 16) for a full numeric string to be entered. Once the user hits <ENTER> to end the frequency string entry, the program calls a library routine 'Set_DDS' on line 19. This routine converts to binary the frequency string residing in '_inbuf' and sends the appropriate control word to the DDS, thus setting the DDS output to that specified frequency. Once that has been accomplished, line 20 instructs the computer to prompt for another command again.

That Wasn't Hard…Was it?

Those readers not into software, not even the least little bit, probably skipped over the last section—and rightly so. For many of you, the joy is not in creating new capabilities, but in using the existing ones. Whatever your preference, this 'Hello DDS' program is still for you because you can have fun creating and modifying the Template as described, or you can just download this program from the Digital Breadboard website, load it into your HC908 card and use it directly. It's that simple. But no matter which route you follow, you'll end up having a new program for your HC908 Daughtercard that can serve an important role on your bench generating useful frequencies for test, measurement and VFO control.

HC908 Test Fixture

I wanted to quickly show you the 'test fixture' that I used to initially program and check out each of the HC908 Daughtercards before shipment. Besides just wanting to show off some of the evolutionary stages of developing this heart of the Digital Breadboard, I also wanted to give you some ideas on how you might package the HC908 card in a functional system.

Figure 4 shows an enclosure containing the HC908 Daughtercard-under-test, with a variety of I/O peripherals mounted on the board. The voltage regulation is in the upper left corner, and the boot programming connector is in the lower right. The bargraph LEDs are used to visually indicate that the the plethora of I/O bits operate properly during Test Program execution. The LCD, the DDS daughtercard, the shaft encoder (with the knob), the potentiometer in the bottom right, and the little switch in the middle-right of the board (serves as the 'Monitor Jumper' to control whether the unit powers up into the Monitor or into the User application) all serve to test the capabilities of the HC908 Daughtercard.

This test fixture also served as my development platform for the Antenna Analyzer II derivative of the Digital Breadboard before the dedicated AntAnal hardware was available. You too could use such a platform in the development of your own custom projects. Just a thought.

Until Next Time

The ideas and examples presented this time certainly give owners of the HC908 Daughtercard lots of ideas to be working on for another couple of months. Even readers without the HC908 platform can

get a fairly good idea of the flexibility and utility of the hardware/software provided in this project. Check the Digital Homebrewing website often, as new material is being added at an increasing rate now that we're over the Daughtercard availability hump. There's lots of fun ahead as we finish off the Antenna Analyzer and present the completed project (and kit) in the enxt installment. Until then, happy QRP computing!

NOTES

1) Visit the online version of the Digital QRP Homebrewing column by pointing your browser to www.njqrp.org/digital-homebrewing. Follow the links on the left side of the page to view the progression of the Digital Breadboard project, including color photos, diagrams, additional description and theory of operation, and software listings.

2) The DDS Daughtercard was described in my Micro Moments section of the last issue, and is now available from the NJQRP. See www.njqrp.org/dds for technical and ordering details.

Spotlight on … The NKØE “"PIC Weather Station” Part 4: Wind Speed

Hi again, folks! In this installment we're going to start working on a homebrew anemometer. I plucked this design off the Internet and adapted it for our use here. The anemometer we're going to build is called the “Easter Egg Anemometer” for reasons that will soon be obvious. The original design can be seen at http://www.otherpower.com/anemometer.html. This design uses a brushless DC permanent magnet motor to which plastic Easter egg halves are attached to make it spin in the wind. Figure 5 shows how it looks from the top, and Figure 6 shows how it looks underneath (where you can see the motor). From the pictures, it should be obvious how this design got its name!

The principle behind this anemometer is that the motor acts as a voltage generator as it spins. The output varies in frequency and amplitude with the speed of the motor. The faster the motor turns, the higher the frequency of the output sine wave. If we amplify this output we can use the PIC to count the frequency of the output and determine from a calibration table the speed of the wind that's making it turn.

I'll mention up front that a shortcoming of this design is that it doesn't work for slight winds. It appears that it takes about 10 MPH or so to get it to measure. Lighter winds either fail to make it turn at all, or it turns too slowly for the output sine wave to be detected. If you're skilled at creating mechanical things, you might be able to come up with a better design. As long as it outputs a series of pulses or a sine wave, it should be usable in place of the Easter egg anemometer.

Building the Anemometer

Luckily, the people who designed this anemometer also sell the motors so others can build it. Go to http://www.otherpower.com/cgi-bin/v2/order1.cgi on the web (or click the “ORDER NOW!” link at the bottom of the anemometer page listed previously), and search the list for “Brushless Permanent Magnet DC Motor for Anemometer.” As I write this, they sell for $2.50 apiece plus shipping.

I constructed my anemometer by gluing a CD to the top of the motor (carefully ensuring that it's centered) such that the CD spins on the motor's axle. Then I took three Easter egg halves, cut slits in their sides (see Figure 7) using a Dremel tool, and glued them in place on the CD by slipping the slits over the edge of the CD. You'll want to make sure that the eggs are distributed evenly around the CD so that the system stays balanced. I recommend using the larger size of plastic Easter eggs.

Figure 7—Mounting slot cut in the plastic egg/anemometer cup.

Those that are the size of real eggs don't work as well as the larger ones.

Of course, feel free to use a design of your own choosing when attaching the Easter eggs to the motor. The only important thing here is that the anemometer must spin at a speed approximately proportional to the wind speed. One thing done in the original article was to glue a fourth Easter egg half over the top of the motor to seal it from the elements. I haven't done that here yet but I probably will.

The motor has three pins for electrical connection. The center pin is ground, and the outside pins would be used to provide

Figure 5—Anemometer construction: top view.

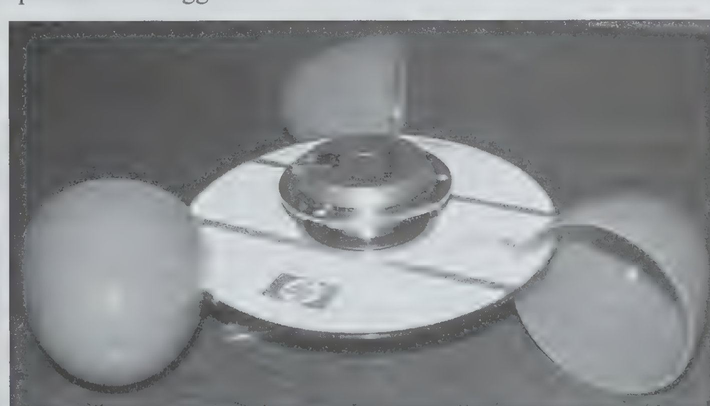


Figure 6—Bottom view showing the DC motor.

the driving signals when used as a motor. In our application, we'll use the ground pin and only one of the outside pins (either one is fine). According to the original design, this motor will produce a 6 Hz sine wave when it is rotated at 1 RPM.

Anemometer Signal Amplification

The amplitude of the signal coming out of the motor when it spins isn't large enough for our PIC to be able to detect the signal, so I added a simple common-emitter amplifier circuit to bump up the voltage. I used the information in the "Hands-On Radio" article by H. Ward Silver, NØAX, from the February 2003 *QST* (pp. 65-66), which worked quite well for my purposes. For the record, here are the design parameters I used:

- Voltage gain $A_V = 10$
- Transistor $\beta = 200$ for the 2N2222A
- Quiescent collector current $I_{cq} = 4$ mA
- Quiescent collector-emitter voltage $V_{ceq} = 2.5$ V
- Supply current $V_{cc} = 5$ V
- Base-emitter voltage $V_{be} = 0.7$ V

If you work out the math given in the article, you arrive at resistors values of $R_1 = 20.3$k, $R_2 = 4.6$k, $R_C = 570$ ohms, and $R_E = 57$ ohms. I chose the standard resistor values of 22k, 4.7k, 680 ohms and 27 ohms to use in my amplifier. N0AX's article does a good job of explaining this amplifier and I won't repeat the explanation here.

PIC Code for Counting Pulses

The code added to our PIC for counting pulses is actually pretty simple and short. The GetWindSpeed subroutine is where the pulses are actually counted. This routine sets up a loop (actually two nested loops) that checks once per millisecond to see if the wind input (RB1) has changed value (gone from high to low or vice-versa). If it has, a 16-bit counter made up of the lo and hi registers is incremented, and the new value of the wind input is saved for the next check. The actual checking and saving is done in subroutine CountWind. GetWindSpeed counts pulses for a total of about 3 seconds, and the total count is saved in lo and hi as a sixteen bit word.

GetWindSpeed is called from one of two other subroutines: TellWindSpeed and TellWindSpeedCW. TellWindSpeed is called from the main program loop when the PIC receives an ASCII "w" via its serial line. TellWindSpeed calls GetWindSpeed, and then calls SendAsciiNum to convert the 16-bit word in lo and hi to ASCII and return it to the PC as a five-digit string. After that, TellWindSpeed calls SendCRLF to send a carriage return and line feed (to go to the next line if you're using something like Hyperterminal for debugging).

So, what the PC gets for wind speed is just a raw number indicating the number of transitions that occurred on the wind input line during the 3-second counting period. Since there are two transitions per complete sine wave, and the motor generates a 6 Hz signal at 1 RPM, you can divide the raw number by twelve to get the RPM of the motor if you'd like. Later we'll use the raw number directly to develop a calibration between the anemometer output and true wind speed.

Calibration Without a PC

The original article explained how they calibrated the anemometer by mounting it on a vehicle and driving at set speeds while observing the output. Although this is a simple and straightforward method, in our case it would require a notebook PC to be used in the car. Not everyone has a notebook PC at their disposal, so I decided to add some code to the PIC that would output the windspeed on an LED using CW when a pushbutton is pressed. Since I already had some code from my Serial CW Sender project for doing so, it took only a matter of a few minutes add the code and get it working. The LED is connected through a 1k resistor to RA0 (pin 17) of the PIC, such that when RA0 goes low, the LED lights. The pushbutton is connected to RB2 (pin 8), and RB2 is tied to +5 V using a 10k resistor, such that pressing the pushbutton grounds RB2, and releasing it causes RB2 to go high.

In the PIC code, TellWindSpeedCW is called whenever RB2 is low (meaning the pushbutton was pressed). TellWindSpeedCW calls GetWindSpeed, but instead of returning the anemometer output via the serial port, it calls SendCWAsciiNum to output the value in CW on the LED. SendCWAsciiNum behaves just like SendAsciiNum except that it calls SendCWChar for each digit to send. SendCWChar is a subroutine that takes the ASCII value in the CharToSend register and

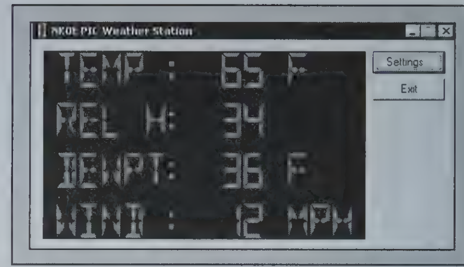


Figure 8—Display with wind speed added to past weather station functions.

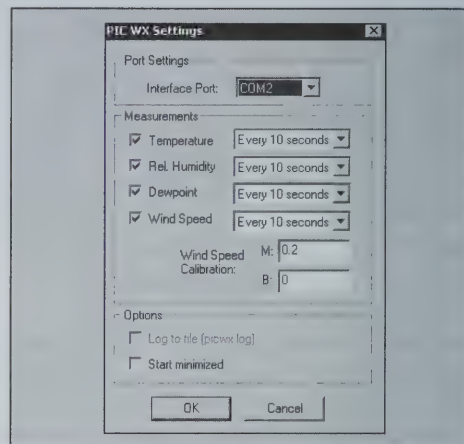


Figure 9—Settings dialog box for entering calibration parameters.

converts it into a stream of dits and dahs. It uses the ASCII value to look up the "CW value" in a lookup table named (appropriately) Table. Table is just a jump table, where the length of the jump is determined by the value in the W register, which is preloaded by SendCWChar. SendCWChar loads it with zero for the "0" character, one for the "1" character, etc. When Table is called, this value is added to the current program counter to make execution shift to one of the "retlw" statements. "retlw" is just a "return" statement where the value following the "retlw" instruction is placed in the W register prior to the return.

The value returned to SendCWChar by Table stores the dit/dah values in the lowest five bits, with a one meaning a dah and a zero meaning a dit. SendCWChar just marches through the bits, sending dits and dahs by calling SendCWDit and SendCWDah, respectively. I restricted the allowed values for CW characters to just the digits zero through nine. If you're interested in a more general capability, Go examine my Serial CW Sender PIC code (which also includes code to handle a paddle). You can see it at http://home.earth-

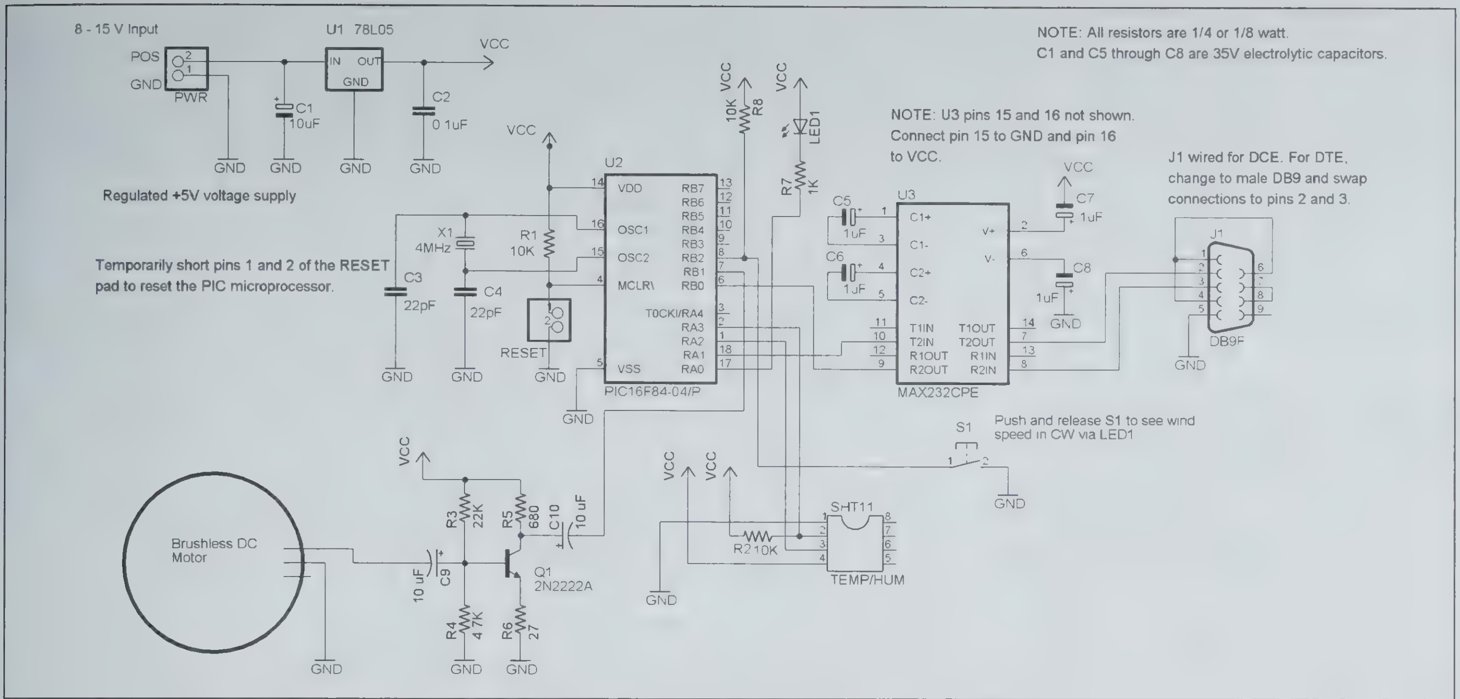


Figure 10—Schematic of the PIC-based weather station with the windspeed indicator added.

link. net/~golog.

With the addition of the LED and the pushbutton, then, you can calibrate the anemometer without needing to use a PC. If you choose not to use this method, the LED and pushbutton can be omitted, but make sure to tie RB2 to +5 V with a 10k resistor.

Calibration

As mentioned previously, probably the easiest way to calibrate the anemometer is to mount it on your car or truck and record the raw anemometer output at various highway speeds. It's important to do this on a calm day, or the wind will skew your values. Once you have created a table that shows the raw anemometer output for each speed at which it was measured, it's easy to determine a simple formula for calculating MPH from any value of anemometer output.

I haven't gotten this far with my own setup yet, but the original article indicates that the response of the anemometer should be linear with wind speed, such that a simple straight line can be drawn through the calibration points. This means that I should be able to convert the raw anemometer output to a wind speed in MPH using a formula like

$$v = mf + b$$

where v is the wind speed in MPH, f is the raw anemometer output, and m and b are constants. Some of you will recognize that formula as being that of a straight line, with a slope of m and a y-intercept of b. In our case, b should be close to zero, and m can be found fairly easily by choosing two data points from your table of calibration data and using the following formula:

$$m = \frac{v_2 - v_1}{f_2 - f_1}$$

where v_2 and f_2 are the speed in MPH and raw anemometer output from one data point, and v_1 and f_1 are the speed in MPH and raw anemometer output from your other data point. It would be best to choose two data points that are at opposite ends of your calibration range.

Another method of obtaining m from your calibration data involves the use of a linear least squares fit to your data points. Many scientific calculators can do this for you. If you'd like this to be done but don't know how, email your data to me and I'll do it for you. In the mean time, a value of 0.2 or so for m will give you ballpark results.

Windows Software

I've modified my Windows software so that it includes an output for wind speed, and so that you can enter wind speed calibration information (the values of m and b previously discussed) for obtaining accurate speeds. Figure 8 shows the new display that includes wind speed. Figure 9 shows the Settings dialog box where you enter values of m and b. Even if you haven't taken any calibration data yet, you can test your anemometer with a fan just to see that the indicated wind speed increases when the anemometer spins faster. Enter a value of 0.2 for m and 0 for b and that should give you reasonable numbers for output. Then try changing the value of m to see how it affects the reported wind speed.

Next Time

That's all for this installment. Next time I'll follow up with my own calibration experience, and then we'll get started on another sensor for the stations (although I'm not sure which one yet). Here's a homework assignment: I've been thinking awhile now about how to design an easy-to-build rain gauge for our system. Obviously, it needs some sort of digital output. Commercial systems use a tipping bucket, where a bucket empties itself when it gets full, and the tipping action triggers a switch. I haven't yet figured out how to homebrew the mechanical parts of such a device yet. Any ideas?

QRV?

"...I can't give you more power, Captain, she's gonna blow!"

Mike Boatright—KO4WX ko4wx@mindspring.com

"Power tends to corrupt, and absolute power corrupts absolutely."*—Lord Acton, in a letter to Bishop Mandell Creighton, 1887*

OK, they say confession is good for the soul, so I have a confession to make: most of my construction time of late has been consumed with building a 300 watt linear amplifier (and power supply). Now, if you are a true QRP zealot, you can stop reading right now, but I want you to know that the point of this article is not to justify building a QRO amplifier (nor how to build it, for that matter). Suffice it to say that another part of my amateur radio hobby is active participation in the Amateur Radio Emergency Service (Section EC of Georgia) and after evaluating needs and available communications resources, I determined that there were times when I needed an extra S-unit (about 6 dB) of signal strength over the 100 watt output that my station was previously capable of producing in order to establish reliable communications on our statewide 75 meter coordination frequency.

The point is that the project has really gotten me to thinking about exactly what *is* power? A quick check of dictionary.com yielded several interesting definitions of the word power:

The ability or capacity to perform or act effectively—I really like this one. Seems to me that it might be the most closely related to that admonition in Part 97 of the FCC rules, "An amateur station must use the minimum transmitter power necessary to carry out the desired communications" (97.313a).

The rate at which work is done, expressed as the amount of work per unit time and commonly measured in units such as the watt and horsepower—This definition of power seems to be related to work. I like that. The less power, the less work. Now that is my style!

The product of applied potential difference and current in a direct-current circuit.— OK, now this is the one we all know and love. Piece of cake. Or actually, piece of pie; P = I x E.

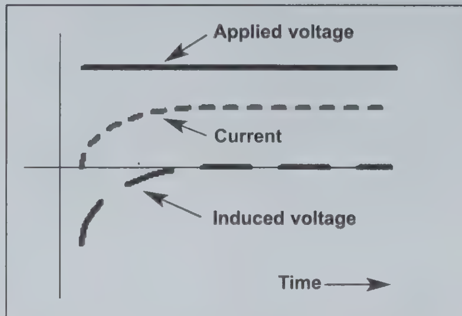


Figure 1—Current/voltage in an inductor.

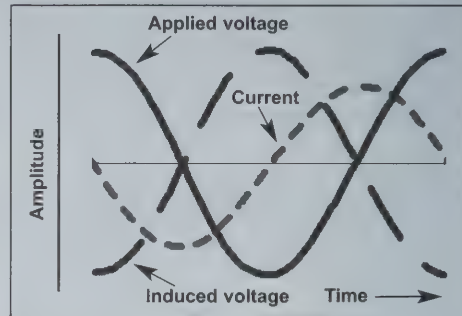


Figure 2—ELI the ICE man.

The product of the effective values of the voltage and current with the cosine of the phase angle between current and voltage in an alternating-current circuit—Ugh! Those nasty phase angles! Man, I just could not get those things straight when I was going for my Advanced ticket. Inductance leads or lags? What about capacitance? Well, good news, in a purely resistive circuit (like the purely resistive 50 ohm loads we would like to be transmitting into), the phase angle is 0 and the cosine of 0 is 1…so I don't know about you, but I think I'll stick with PIE.

How Do I Get Power?

Ah, the question for the ages, some might say. There seems to be only two ways of getting power (1) kiss a whole lot of babies or (2) use a power amplifier (Senator Barry M. Goldwater, K7UGA, SK, probably did both!).

I've always wondered how a power amplifier works, but if you think about it, it is really quite simple. It all goes back to P = I x E. If you increase either I (current) or E (voltage), you get more power. It should be really easy to increase voltage-just about any transformer will do that, right?

Well, yes...and no. A transformer is made by putting one coil (the primary) in close proximity to another coil (the secondary). The voltage in the first coil induces an electrical voltage into the second coil via a magnetic field.

Remember the science experiment where you make an electromagnet (a coil wound on a iron bar, hooked up to a battery) cover it with a piece of paper and shake iron filings on the paper? You can actually see the magnetic field that is created by the electromagnet. When you apply energy to an inductor, work is performed in transforming the electrical energy (from a battery or signal generator) into magnetic energy (the magnetic energy that induces the magnetic field into the second inductor). This means there must be a voltage drop in the circuit as the electrical energy is converted into magnetic energy-that is, as it is stored in the magnetic field. (Note that there is also a small voltage drop due to resistance in the wire and other losses in the circuit, but it can be ignored for the sake of simplicity).

But the magnetic field is also inducing a voltage into the second coil. As the voltage drops in the first coil, it rises in the second. One gives energy, one takes energy, but no new energy is added to the circuit. Therefore, this induced voltage is always such as to oppose any change in the circuit current (if the current changed, then the power would have to change, and vice versa).

Since only so much work is being performed to turn the electrical energy into magnetic energy, and since P = I x E, as the voltage drops, the current must rise until the field reaches the maximum value that the electrical energy source is capable of producing in the inductor (that is, no more work is performed as the field has reached its maximum)—see Figure 1. The inductor

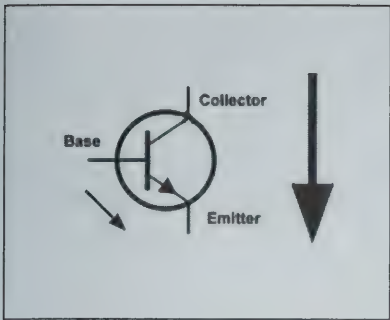


Figure 3—Bipolar transistor.

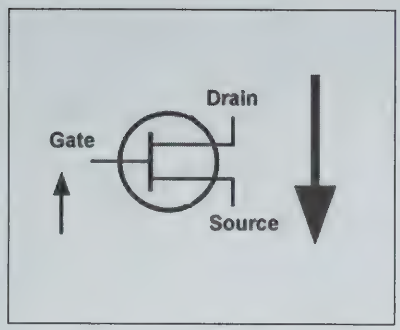


Figure 4—Field effect transistor.

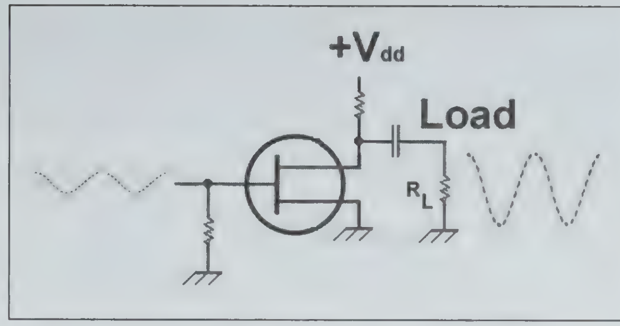


Figure 5—Simple power amplifier.

tries to maintain a constant current through the circuit.

This is what happens when a direct current is applied to an inductor/transformer. But we all know that transformers only work on alternating currents, like RF, right? Well, sort of. Because the voltage of an alternating current is constantly changing, the induced voltage is constantly changing as well. But the inductor is trying to maintain a constant current. The net result is that when an alternating voltage is applied to an inductor, the current is 90 degrees out of phase with the voltage, that is, current lags voltage in an inductor (and it leads it in a capacitor, remember the ELI the ICE man?)—see Figure 2. The lag in current is a result of the reverse voltage (or induced voltage) generated in the inductance. The amount of reverse voltage is proportional to the rate at which the current changes, e.g. the frequency of the alternating current.

In a DC circuit, the opposition to the flow of current is called resistance. In an AC circuit, it is called reactance and is a function of the amount of inductance and the frequency of the alternating current. All practical circuits-including AC circuits-have some resistance, and the combined effect of resistance and reactance is called impedance.

One interesting property of transformers-is that the impedance of the load is proportional to the square of the ratio of the number of primary coil turns to secondary coil turns. While this is not very useful for amplifying power, it is very useful for transforming it, as we will see next. It is important to understand that transformers-while being very useful to transfer power, change voltage and transform impedance-they cannot create power. In fact, there is always some power loss in a transformer due to the resistance of the wires and other causes (power loss must be dissipated in some form, usually as heat).

Pump Up the Volume

A amplifier is a circuit which can create power. Well, really it cannot create power, but it can cause an increase of voltage or current (or both) of an input at the circuit's output. Most amplifiers are made from either vacuum tubes or from transistors. Because most (but not all) vacuum tubes require very high voltages to operate, transistors are preferred for many amateur applications.

The transistor has the interesting property that an increase in it's input causes a corresponding increase in its output current. In a bipolar transistor (Figure 3), a change in the current flowing from the base to the emitter causes a significantly greater change in the flow of current from the collector to the emitter. This is called the common emitter configuration. In this configuration, collector current flows in proportion (called the beta, or β) to the base current. It should be fairly easy to see that by carefully setting the base to emitter current (called biasing), we can create a circuit using a bipolar transistor that will amplify a signal.

A field effect transistor or FET (Figure 4) also exhibits what is known as transistor action, but in a slightly different manner than the bipolar transistor (actually, it behaves very much like a triode vacuum tube). An FET has a gate, drain and source instead of a base, collector and emitter. When the voltage on the gate of an FET is increased, a proportional increase in the drain to source current occurs. This is called the common source configuration.

If you remember from Ohm's Law, a voltage drop is achieved by passing a current through a resistance, that is, E = I x R, so it follows that power (P = I x E) must be transferred into a resistance to be effective (that is, to do work!). This is called the load (see Figure 5).

The peak positive voltage of the output signal cannot exceed the supply voltage, +Vdd. From Ohm's Law, then, the power output to the load, Pout = $Vrms^2$/RL (where RL is the resistance of the load), or, Pout = $Vpeak^2$/(2 x RL). Or, put yet another way, RL = Vdd^2/(2 x Pout). This equation becomes useful when it comes time to trying to figure out the proper load to generate a specific power output. For example, say you want your amplifier to output 5 watts of power, and you have a 12V supply, then RL = 12^2/(2 x 5) = 144/10 = 14.4 ohms.

Most amateur radio antenna equipment is designed to optimally deliver power into a 50 ohm load. If we were to use a 50 ohm (resistive) antenna system as the load for our amplifier, we would have a VSWR of 3.5:1, a very serious mismatch, the net effect of which is that over 30% of the output power is reflected back into the circuit-in other words, the power output of our amplifier is reduced from 5 W to 3.4 W! Worse than that, depending on its phase, it is quite possible for the signal being fed back to create a very high drain to source voltage, which could possible reduce your transmitter to pre-Marconi technology—that is, to sending smoke signals!

This is where that transformer we talked about earlier comes in handy. A 4:1 impedance transformer (2 to 1 ratio, primary turns to secondary turns) would just do the trick-that is, transform the 14.4 ohms to 50 ohms (actually, it's 57.6 ohms, resulting in a 1.15:1 VSWR, which causes the output to be reduced by 0.49%, or 25 mW, but who's counting?).

Figure 6 shows a practical FET amplifier, using the common IRF510 MOSFET (metal oxide semiconductor field effect

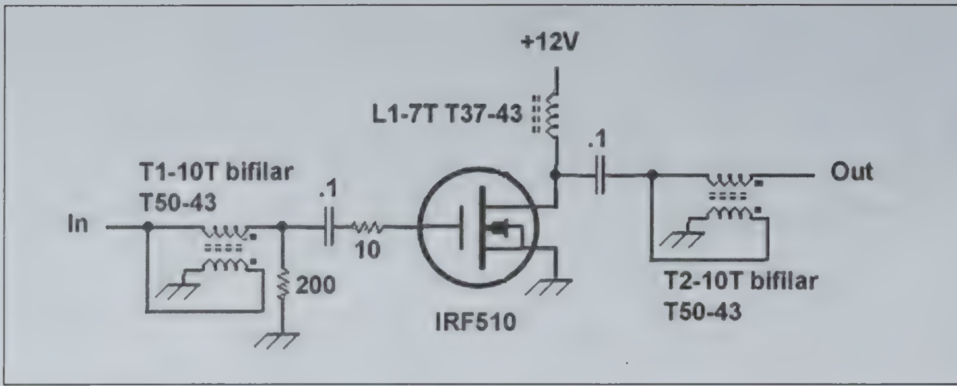


Figure 6—Practical broadband power amplifier.

transistor), available at most Radio Shack stores. The transformers, T1 and T2 are 4:1 broadband impedance transformers (they are a special type of transformer called a transmission line transformer, but they work the same as a 2 to 1 turns ratio transformer). T2 transforms the 14.4 ohm load to 50 ohms. T1 matches a 50 ohm input to the 200 ohm load resistor—the purpose of this resistor is to absorb the input power, since only voltage is needed to drive the MOSFET, not current.

The two capacitors serve as DC blocking capacitors. L1 serves as a constant current source for the load (remember that an inductor wants to keep current constant).

Put 700 mW into this amplifier and you should get close to 5 W out. That's a good 8.5 dB gain, the same gain as you would get from increasing 100 W to 700 W—more than twice the power of the linear that I built!

Now, many of us call 5 watts a QRP gallon. I say, get it on the air and call it QRV!

—72 de Mike, KO4WX

dBm - Volts - Watts Power Conversion Chart (into 50 ohms)

dBm = 10 log (P in mW) $P = V^2_{RMS}/R$ $P = (V_{PP} \times .3535)^2/R$

dBm	V_{RMS}	V_{PP}	Watts	dBm	V_{RMS}	V_{PP}	Watts
+40 dBm	22.5 V	63.6 V	10.1 W	-30 dBm	7.1 mV	20 mV	1 µW
+38 dBm	18.0 V	50.9 V	6.4 W	-35 dBm	4.0 mV	11 mV	0.3 µW
+37 dBm	16.0 V	45.3 V	5.0 W	-40 dBm	2.25 mV	6.36 mV	
+36 dBm	14.1 V	39.9 V	4.0 W	-45 dBm	1.25 mV	3.54 mV	
+34 dBm	11.5 V	32.5 V	2.5 W	-50 dBm	.71 mV	2.0 mV	
+32 dBm	9.0 V	25.5 V	1.6 W	-55 dBm	.40 mV	1.1 mV	
+30 dBm	7.1 V	20.1 V	1.0 W	-60 dBm	.22 mV	.62 mV	
+28 dBm	5.8 V	16.4 V	640 mW	-65 dBm	128 µV	362 µV	
+26 dBm	4.4 V	12.4 V	400 mW	-70 dBm	71 µV	201 µV	
+24 dBm	3.6 V	10.2 V	250 mW	-75 dBm	40 µV	113 µV	
+22 dBm	2.8 V	7.9 V	160 mW	-80 dBm	22 µV	62 µV	
+20 dBm	2.2 V	6.2 V	100 mW	-85 dBm	13 µV	37 µV	
+18 dBm	1.8 V	5.1 V	64 mW	-90 dbm	7 µV	20 µV	
+16 dBm	1.4 V	4.0 V	40 mW	-95 dBm	4 µV	11 µV	
+14 dBm	1.1 V	3.1 V	25 mW	-100 dBm	2.25 µV	6.36 µV	
+12 dBm	0.9 V	2.5 V	16 mW	-102 dBm	1.80 µV	5.09 µV	
+10 dBm	0.7 V	2.0 V	10 mW	-104 dBm	1.41 µV	4.0 µV	
+8 dBm	580 mV	1.6 V	6.4 mW	-106 dBm	1.18 µV	3.33 µV	
+6 dBm	445 mV	1.3 V	4.0 mW	-108 dBm	0.90 µV	2.5 µV	
+4 dBm	355 mV	1.0 V	2.5 mW	-110 dBm	0.71 µV	2.0 µV	
+2 dBm	280 mV	0.8 V	1.6 mW	-112 dBm	0.58 µV	1.6 µV	
0 dBm	225 mV	640 mV	1.0 mW	-114 dBm	0.45 µV	1.3 µV	
-2 dBm	180 mV	510 mV	648 µW	-116 dBm	0.36 µV	1.0 µV	
-4 dBm	141 mV	399 mV	398 µW	-118 dBm	0.29 µV	.82 µV	
-6 dBm	115 mV	325 mV	265 µW	-120 dBm	0.23 µV	.65 µV	
-8 dBm	90 mV	255 mV	162 µW	-122 dBm	0.18 µV	.51 µV	
-10 dBm	71 mV	201 mV	100 µW	-124 dBm	0.14 µV	.40 µV	
-15 dBm	40 mV	113 mV	30 µW	-126 dBm	0.12 µV	.34 µV	
-20 dBm	22 mV	62 mV	10 µW	-128 dBm	0.09 µV	.25 µV	
-25 dBm	13 mV	37 mV	3 µW	-130 dBm	0.07 µV	.20 µV	

Peaux Displaced Cajun Lad in Maine

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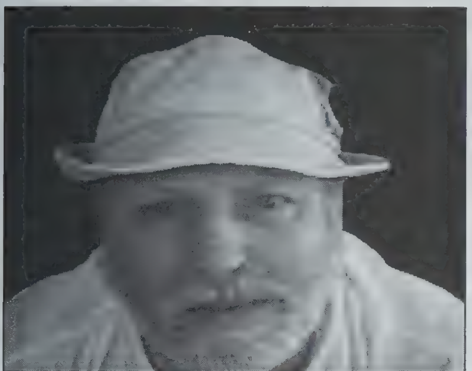

High Y'all, done ah aver told u bout my friend Sheet Boudreaux... He was quite a guy... dey say when he been born and his daddy asked what to name him.... he said... "sheets man, ah don't kneaux." and dats how his son got named Sheets Boudreaux...

What bee worse Sheets done growed up and make a pirogue what bare his name.... sheet's pirogue...which wasn't bad....but then some wise guy decided to call one of them creaks after him....U kneaux, sheets creak...U aver ban thair... seems most folks have at one time or the other....It's just on the other side of Breaux Bridge La....in Lafayette parish....beautiful little creak...It branches out near the top and though u seem by u-self...thair could be lots of other folk up sheets creak with u....and u would never kneaux...

In the evening a stiff little breeze comes up what can get u up sheets creak in a hurry but, man, don't u lose ur paddle neaux... Up sheets creak in the late afternoon without a paddle is a bad place to be....and meaux than one folk done found that out....Kinda funny u kneaux... an easy place to got u-self into but it can be a bugger to got u-self out of...

One day, while paddling my pirogue up sheets creak....ah done got myself lost...so ah got on my K2 and called Alphonse... (7.044 cw) and expained my situation to him....he said not to worry and then he gone got Ti-Fu and they went got in Alphonse's airplane....Soon enough ah could hear Alphonse's plane overhead so ah called him on my 2 meter hand held...

Hey Alphonse u see me yet? See U, he said... all I can see is tree tops....u in a jungle down thair....I smiled and said yea, sorta, I'm up sheets creak...And can't find the wind....can u tell me what way is south....? Yea Joel, it just to my left....can't u feel the wind? NO I can't Alphonse... the trees must be blocking it... Well don't worry Joel, we gots a yellow smoke marker. Ah gonna have Ti-fu hold the smoke marker outside the window and whan u saw the smoke u can tell what way the wind be blowing.... Great idea Alphonse... ah owes u one....

What ah can't see and don't kneauxs is what Ti-fu done pulled the pin on that smoke marker and drop the marker in the plane and held the locking pin out the window...in the meantime the airplane, filled up with smoke...what billowed outta the windows of the plane as Alphonse done stuck his head outside the window on his side to see whare he be going... Folks what saw the whole thing say it was quite a sight... A one man air show, as Alphonse looped and rolled and done some down right scary things with that airplane trying to see and fly the thing....while yellow smoke come billowing out the airplane...

All what I kneaux is soon I see this smoke over the trees and which way it be moving and then I was able to got myself back from up sheets creak... Later on, when ah done gots back home ah went on ovah to Alphonse's house to see him and Ti-fu...yellow as smoke die...both of em, from head to toe....

Dat's when Alphonse tell me how Ti-Fu done climbed his self out through the passanger side window and onto the wing support while they be rolling and looping.... he said folk done thaought he be wing wallking...but Ti-Fu be so scared he done left finger marks in the sheet metal on the plane....and was still hanging on the wing strut whan they landed...

Dang dat sounds exciting, I tells Alphonse, sure wish ah had been up thair with u instead of lost up sheet creak....funny u kneaux that done nevah happened before...ah was only about a mile off course....got to due some good fishing u kneaux...sheaux glad u was monitoring 7.044....

No problem, said Alphonse, ...course we owe all the excitement to Ti-Fu... U kneaux ur right ah said...and whare was Ti-Fu, I asked...oh said Alphonse, he's got his head in the john, quite airsick u kneaux....

And so it was...u kneaux...sometimes the rescuer gots themselves into worse shape than the rescued...

Y'alla be good now,

—KE1LA , Joel

... Freezin in Maine

Attention QRP Contesters!

Mark your Calendars:

Hoot-Owl Sprint
May 25, 2003

Milliwatt Field Day
June 28-29, 2003

Summer Homebrew Sprint
July 13, 2003

Test Topics and More

Joe Everhart—N2CX

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In the last installment of TTAM the main topic was the "Q" or *quality factor* of reactive components such as inductors and capacitors. Several circuit techniques were described and some practical difficulties of each approach was outlined. This time around we will see several more methods and look at techniques for making Q measurements. Two terms associated with Q testing will be explained in Coming to Terms. To complete the discussion, Designed For Test will present two methods to accurately measure Q. Both methods are practical for the average homebrewer without special test equipment, techniques or calibration.

The last column concentrated on Q measurement circuits and was intentionally mum about how one actually goes about measuring Q. This was necessary so that some of the circuit concepts and limitations could be presented. This time we will get down to brass tacks!

Coming to Terms

The first Q measurement method has the fancy name of the "Reactance Variation Method." Though the name may not be familiar, the concept probably is since it's the most common way that homebrewers measure Q. We'll skip the heavy-duty math and go right to the principles involved. Refer to Figure 1 for a conceptual diagram of the test setup used. This is similar to Figure 4a from last time with one important difference-for explanatory purposes we simply assume that the signal source impedance is high enough that it can be connected to the parallel tuned circuit without affecting its Q.

We know that a parallel resonant circuit shows its highest impedance at its resonant frequency (Fo). So the voltage across the circuit is highest at this point. As the signal generator is varied either side of this center frequency, the impedance of the tuned circuit is reduced. Higher in frequency the reactance becomes capacitive and below resonance it becomes inductive. As the impedance drops off either side, so does the voltage across it. By definition, the bandwidth of the circuit is measured at 3 dB (half-power) points where the voltage decreases to 0.707 times the maximum center frequency voltage. The bandwidth is the upper 3 dB frequency (Fhi) minus the lower 3 dB point (Flo). And the Q is the center frequency divided by the total 3 dB bandwidth or

$$Q = Fo/(Fhi - Flo).$$

Figure 2 illustrates this better than 1k words.

The second Q measurement method is called the "Resonant Rise Method." The analog of Figure 4b from last time is shown in Figure 3 to illustrate the principle. A signal source with a very low impedance (Rg) is connected in series with the ground lead of the test inductor. The voltage across this resistor is set to a predetermined voltage (Vg). A capacitor is used to resonate the circuit as before. Voltage across the capacitor is measured with a high impedance RF voltmeter. If the generator internal impedance is much lower than the loss resistance of the inductor (the capacitor is assumed to be lossless) its effect will be minimal.

At resonance the reactances of the inductor and capacitor cancel so the Vg and the series loss resistance of the inductor set the current through the whole circuit. This current also flows through the inductor being tested and the tuning capacitor. The voltage across the capacitor (Vc) is this current multiplied by the capacitor reactance (which is also equal to the inductor's reactance at resonance). With a little algebra you can convince yourself that voltage Vc is equal to the ratio of Rg and Rs so it is numerically the same as the Q of the inductor. So if by measuring Vc with a fixed value of Vg you measure Q!

The resonant rise method is most often employed in commercial instruments like the venerable Boonton Q-Meters (references 1, 2, 3, 4) and the more modern HP-4342A Q-meter (reference 5). They are certainly deluxe instruments and the best choice though it may be hard for any but the most diehard homebrewer to justify their cost and upkeep for special purpose test equipment.

Several homebrew Q-meters emulating these instruments have appeared in ham radio magazines over the years (references 6, 7, 8). The approaches taken in both demonstrate the difficulty of overcoming the challenges outlined in part I of the Q-meter saga in the last TTAM. You may care to check them out as well as the commercial Q-meter references for ideas. However I'll discuss some simpler methods in the next section.

Designed For Test

Long-term readers of this column know that one of my overall goals in designing homebrew test equipment is to end up with something that is straightforward to build, can be made with components that are commonly available and that the end performance of the design is repeatable and can be calibrated without access to a special calibration laboratory. That's usually quite a tall order…

Here are two conceptual methods for building some fairly simple test gear for Q measurement.

The first comes from a number of arti-

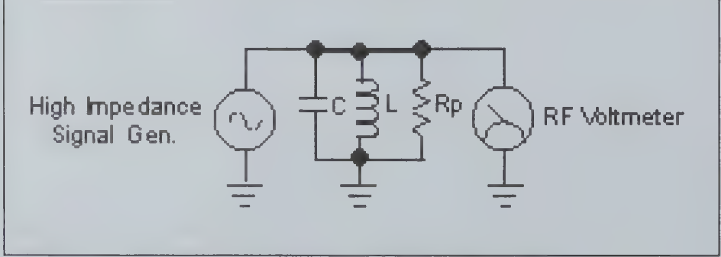

Figure 1. Reactance variation method test circuit.

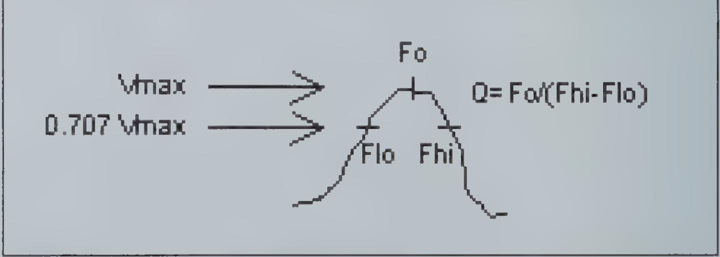

Figure 2. Q from resonance curve.

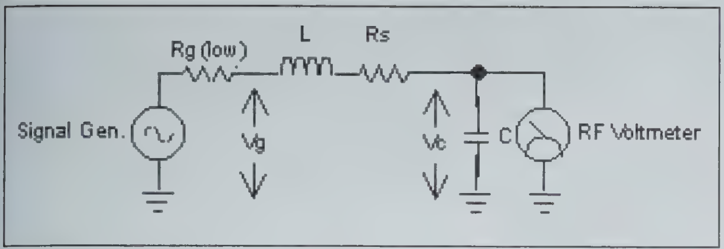

Figure 3. Resonant rise method.

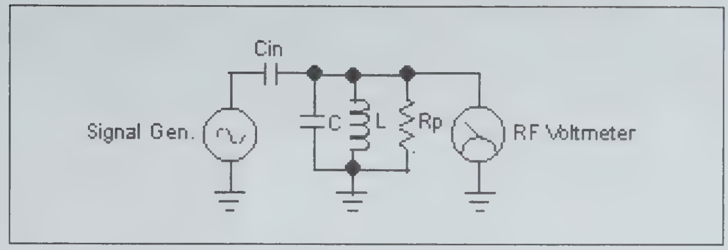

Figure 4. W7ZOI Q measurement circuit.

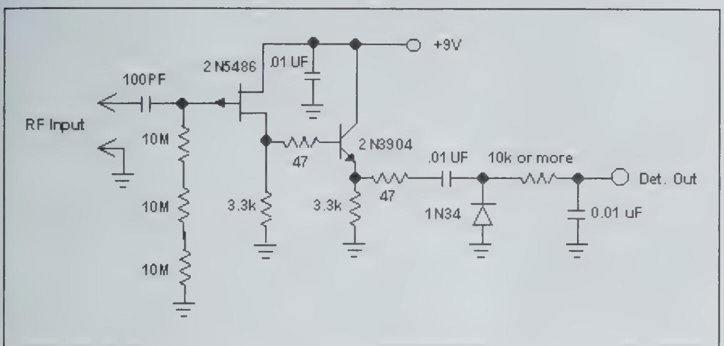

Figure 5. Hi-Z probe followed by a diode detector.

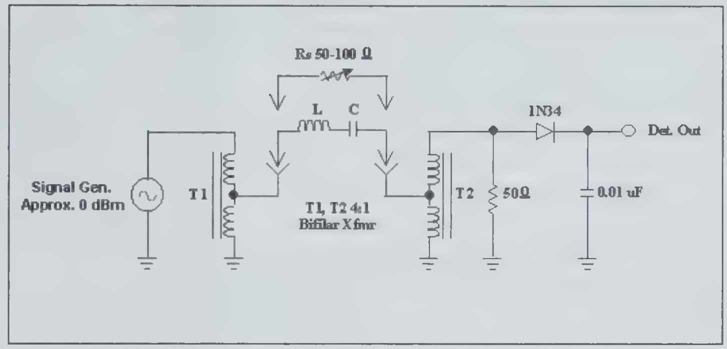

Figure 6. Q measurement by substitution.

cles written by Wes Hayward, W7ZOI. His writings have discussed quite a few filters and resonators over the years and most of them have required determining or at least estimating inductor Q so that filter performance could be assured.

His technique uses the Impedance Variation method described above. Figure 4 shows the circuit he uses for this. As has already been beaten to death, the difficulty in using this method is in connecting the signal generator to the resonant circuit without loading it down. His circuit uses a very small capacitor Cin. Some math can be used to show that the smaller this capacitor is, the less loading it imposes. Practically speaking a Cin value of 1 pF will add very little loading to a 7 MHz resonant circuit with a 100 pF capacitor and 5.17 μH inductor. The downside is that the high impedance of this small series capacitor decreases the voltage across the tuned circuit. It takes some experimentation to find a value that is high enough to give usable signal levels but is small enough that it has a small loading effect on the circuit.

Now measuring the tuned circuit voltage without loading is yet another challenge. Most ways of doing this severely attenuate the signal you are trying to measure. However TTAM 11 described a "Poor Man's" Hi-Z probe that fits the bill. Simply use this probe followed by a common diode detector and you have a good functional circuit. See Figure 5.

You have to keep a couple of things in mind when using this circuit to maintain accuracy. The diode detector becomes very inaccurate at low signal levels so you want to be sure that the voltage across the tuned circuit is at least a volt or so peak to peak. Simply setting it close to this value at resonance is ok. You won't be measuring the absolute voltage value but only its peak value and the 0.707 points. On the other hand the Hi-Z probe will not work if the input is too high since it operates from a 9-volt battery. If the voltage across it is more than a couple volts peak-to-peak it will become very non-linear. So it's best to try to operate it will peak voltages between 1 and 3 volts or so peak-to-peak.

The second Q-measuring circuit is adapted from a quartz crystal measurement circuit, which I first saw in an article by W7ZOI (reference 9, 10). It is further refined with a pair of broadband transformers as Jim Kortge, K8IQY, presented in a most interesting presentation at Atlanticon 2002.

Figure 6 shows the circuit. A tunable signal generator is fed to a series resonant circuit and the output of the circuit is fed to a diode detector. T1 and T2 step the 50 Ohm generator impedance down then up to drive the circuit with a low impedance while not wasting the power that a resistive divider would. The output of the tuned circuit then feeds a simple diode detector. An external DC meter connected to the detector output is used to monitor it.

Recall that a series LC circuit has minimum impedance at resonance. To use the test circuit, adjust the generator for maximum output as measured on the DC meter. Carefully note the DC level. Now replace the LC circuit with trimpot Rs. Adjust Rs to obtain the same DC output level as with the LC circuit. It is now identical to the series loss resistance of the inductor. Remove the trimpot from the circuit and measure its value with a DC ohmmeter. The inductor Q can then be simply calculated by dividing the inductor impedance by the value of this resistor. You can determine the inductor impedance with the formula:

$$X_L = 2\pi F L$$

where F is the resonant frequency and L is the inductance. Knowing the marked value of the capacitor you can estimate the inductance using the usual resonance formula.

References

1. "The Q-Meter, the Homebrewer's Friend," Mike Czuhajewski, WA8MCQ, Idea Exchange column, *QRP Quarterly,* October 1991.

(continued next page)

A 20 Meter Transceiver

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What possesses a ham to build his own equipment? At one time, the price of equipment which could be purchased off-the-shelf, and it's lack of availability, was a sufficient enough reason to roll your own. Nowadays, the motivations are more pure: knowledge gained from converting a concept in your head to a tangible, operating piece of equipment, gaining valuable "RIG HR IS HB" bragging rights, or just proving to yourself it can be done.

Nothing along these lines drove me to build this 20 meter QRPp rig. Rather, I was fortunate to obtain at one of our radio club auctions (for the fine price of 50 cents) a defunct RF signal generator with a beautiful 2.5:1 dial drive and matching tuning capacitor. It could probably have been restored to operation, but I didn't need another signal generator. I salvaged a few of the innards—a nice set of plug-in oscillator tank coils, the power transformer, tube sockets, and the apparently good 6J5s that were in them. The fine patina of rust covering the case was easily removed. Gutted, except for the tuning capacitor and dial, the signal generator's carcass languished for several months in my junk box. I would give the tuning knob a spin every once in a while, hoping perhaps to feel some grittiness or objectionable backlash which could be my excuse for heaving it in the trash, but no such excuse offered itself.

After several months being taunted by this thing, I gave in. I had already built 40 meter and 30 meter half-watt rigs with very different designs to give me QRPp coverage on two of my favorite bands. I had a legitimate need for a 20 meter version, I told myself, if for no other reason than to use that pesky signal generator hulk. The decision having thus been made, I painted the cabinet with bright red enamel to keep the rust at bay. The color, based on suitable paint already on hand, was also a nod to the devil that made me do it.

KG4CUY's homebrew 20M transceiver, built into a refurbished signal generator cabinet.

Design rule #1 was to use the dial drive and tuning capacitor (whatever value that capacitor might actually be was not an issue). Design rule #2, a close second, was to avoid flagrant "misuse" of the newly-painted cabinet. I had no qualms doing whatever was necessary to the chassis, but the cabinet and set of black knobs I assembled looked rather nice. Rule #2 also meant no new holes in the front, and to put some sort of meaningful control behind those knobs. There were six knobs, plus a six-position pushbutton bandswitch.

Those were the rules. Here's what came out of them.

Receiver

At 14 MHz, LC oscillator stability would be a concern, so I decided on a single conversion superhet with an 8 MHz IF to use up some of the many 8 MHz crystals on hand. A 6 MHz local oscillator was much more palatable, and the local oscillator drives a double-balanced diode mixer through several stages of buffering. The mixer's RF port is driven through a two-resonator preselector.

I had wanted to build a variable-bandwidth crystal filter into something, and this project was the perfect candidate since I had crystals and could use another control to satisfy rule #2. A few kHz of varactor tuning on the local oscillator provides receive offset tuning. This is handy because a lot of QRM can be eliminated by tightening down the filter bandwidth and using RIT to control just where the desired signal appears in the IF passband.

An 8 MHz VXO BFO, twin-tee active audio filter, and audio output stage complete the receiver, with audio-derived AGC controls IF gain.

Transmitter

An NE602A mixer's built-in oscillator controlled by an 8 MHz crystal beats with the local oscillator, then is filtered by a two-resonator bandpass filter to select the upper mixing product, to generate the 14 MHz transmit signal. This drives a cascaded driver, the final, and a 5-element low-pass filter to deliver a mighty 750 mW into 50 ohms.

(Test Topics and More...continued)

2. "Q Meter Update," Mike Czuhajewski, WA8MCQ, Idea Exchange column, *QRP Quarterly*, April 1992.

Note: Refs 1 and 2 are available on the web at: ftp://qrp.lehigh.edu/pub/listserv/qrp-l/articles/qmeter.mcq.z

3. "Boonton Q Meter Repair Hints and Comments," http://www.qsl.net/k5bcq/qmeter.htm

4. "Q Meters," by Keats A. Pullen, Jr., W3QOM, *Ham Radio*, December 1989, pp. 49-52.

5. HP 4342A Operation and Maintenance Manual by Hewlett-Packard (now Agilent Technologies).

6. "An Experimental 'Q' Meter," Lloyd Butler, VK5BR, http://www.r.tpgi.com/au/users/ldbutler/Qmeter.htm

7. "Novel Q Meter," Edgar McKenny Egerton, Jr., *Electronics and Wireless World*, October, 1986, pp. 38, 39.

8. "A Crystal-Controlled Q Meter," Frank Noble, W3MT, *QST*, May, 1984, pp. 11-14 (reactance variation method).

9. "A Unified Approach To The Design Of Crystal Ladder Filters," Wes Hayward, W7ZOI, *QST*, May, 1982.

10. "Designing and Building Simple Crystal Filters," Wes Hayward, W7ZOI, *QST*, July, 1987.

Sidetone generated by an op-amp oscillator is shaped into a sine wave and fed to the audio output stage during transmit. Switching between receive audio and sidetone is done by CMOS bilateral switches controlled by the transmit/receive switch and keying voltage.

Keying

Manual transmit/receive switching is used. In transmit, the receiver is muted, the RIT is disabled, and the antenna switching relay is energized. The driver is keyed by a switch transistor which also shapes the keying.

Miscellaneous

The tuning capacitor range turned out to be 20-340 pF, which was combined in series and parallel with fixed capacitors to form, in conjunction with a slug-tuned coil, the parallel tank circuit for a Colpitts oscillator. A pair of back-to-back varactors across the lower feedback capacitor controls receive offset. A fixed varactor voltage is selected during transmit; a variable voltage controlled by a potentiometer during receive allows the receive offset to be on either side of the transmit frequency. The proper voltage is selected by CMOS switches.

Unregulated +12V and regulated +6V and +9V power is provided to various parts of the circuit. A 2-pole 3-position wafer switch from the original signal generator is used as the power/transmit/receive switch, and along with some transistor switches, provides the separate +6V, +9V, and +12V transmit and receive power to drive various portions of the circuit depending on the switch setting.

Rule #2-wise, all the holes had been plugged except the pushbutton bandswitch. This was pressed into service as an RF gain/attenuation selector positioned after the preselector. One pushbutton position selects 16 dB gain provided by an MMIC gain block, the second position is straight through, and subsequent positions select 10 dB and 20 dB attenuators. Alas, two positions remain unused—they really should be used for additional attenuators, and perhaps some day I will get around to that.

Physical Layout

Transmitter, receiver, and local oscillator assemblies contain most of the circuitry. The local oscillator is built in a 5-sided box made of PC board stock, and mounted against the plate to which the tuning capacitor is attached, completely shielding it for stability. The receiver is a 3 x 6 inch PC board and is enclosed in a 4-sided PC board box, mounted against the other side of the same plate. The transmitter is built on a 3 x 4 inch PC board. Phono jacks are used on all assemblies for RF connections, and barrier terminal strips for power wiring and connections to the front panel potentiometers.

Regular 1/4 inch phone jacks accept key and headphone connections, compatible with my other gear. Banana jacks for power and the SO-239 antenna connector fill the other holes on the very sturdy, hard to drill, and even harder to file, back panel.

On the Air

The 13.8 VDC supply that runs much of the shack powers this radio as well. I have only a trap dipole for 20 meters, and find that the antenna tuner settings which keep my QRO rig happy also provide a good match for the Red Radio. After five minutes warm-up, the local oscillator is quite stable, and the receiver works just fine for low power rag chewing, which is my operating staple. In retrospect, I would leave out the preamp and add more attenuator settings.

Book Reviews

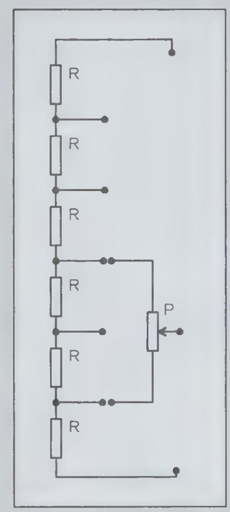
Tony Fishpool—G4WIF g4wif@gqrp.co.uk

RSGB Technical Topics Scrapbooks (Volumes 1, 2 & 3)

One of the most convincing arguments for cloning just has to be that the Radio Society of Great Britain's Pat Hawker, G3VA, simply can't be with us forever. Pat is a national treasure and has been producing the "Technical Topics" column in *RADCOM* [the monthly journal of the RSGB—ed.] since 1958.

"Technical Topics" is a collection of ideas and circuits a little similar to *QST*'s "Hints & Kinks" but more technical in nature. The RSGB now has three volumes—or "scrapbooks"—covering all of "Technical Topics" from 1985 to 1999. They are available from the ARRL Bookstore (http://www.arrl.org)

To describe them as invaluable may seem to overstate their worth but believe me they are just that. These scrapbooks are stuffed with antennas, transmitters and receivers and simple little ideas like the one in the adjoining sketch. It is a simple and cheap alternative to a multi-turn potentiometer. You can wire the resistors around a 5 way rotary switch and connect an ordinary pot as shown. If each of the six resistors "R" have the same value and P = 2R then there will be no overlaps. If P = 3R then there will be a 20% total overlap.



"Helipot" multi-turn potentiometer alternative.

I've never seen this idea published anywhere except in "Technical Topics." Take one of these scrapbooks on the next plane trip and you will wonder where the time went!

Antenna Topics

The next book recommendation seems to be an obviously a blatant attempt by the RSGB to recycle the whole thing again-and then again, maybe not. This book contains all the antenna related article from "Technical Topics" from 1958 to 1999. So if antennas are your thing and you don't have the above three volume scrapbooks then this may interest you. I just love books and have them both, but in any event, this one goes back all the way to 1958 and antennas don't date as easily as electronics. I also have the *ARRL Antenna Compendiums* and *Antenna Topics* is far richer in content.

Both books have been well produced given that some of the early articles must be scans of magazines that will be getting well wrinkly by now. My only criticism is that the indexes are fairly sparse and you will want to make notes of ideas that catch your eye otherwise you may have to read the books again just to find them!

Modifying the Heathkit HM-102 for QRP

Donald E. Sanders—W4BWS w4bws@juno.com

Editorial comment: The Heath HM-102 is an SWR and power meter with full scale readings of 200 and 2000 watts. Dr. Donald Sanders, W4BWS, posted this modification to QRP-L, the Internet QRP forum (http://qrp.lehigh.edu/lists/qrp-l/). Used with permission, this article is adapted from his posting. I found the schematic for the unit on the Internet and redrew it as best I could. Some of the component values were a bit fuzzy and hard to interpret, so I accept responsibility for any errors in it. A partial copy of the manual can be found at this URL: http://bama.sbc.edu/heath.htm. Scroll down the page and click on HM-102, which will take you to an FTP download directory. —*WA8MCQ*

I modified an old Heath HM-102 to be more useful for QRP, enabling it to read 2 watts full scale on the 200 watt range and 20 watts on the 2000 watt range. Figure 1 shows the schematic of the unmodified unit, and Figure 2 shows the changes.

Modification Procedure

1. Add a jumper across R8, 22k, and R9, 82k, which are in the signal path for the 2000 watt range. Adjust the POWER CAL potentiometer so that 20 watts reads full scale on the 2000 watt range. (Alignment requires that you have another accurate power meter to use as a reference).

2. Add a 10k ten turn trimpot (the small, screwdriver-adjust type) across R5, 90k 1%, which is in the path for the 200 watt scale. Set the front panel switch to the 200 watt position and adjust the added trimpot to make 2 watts read full scale on the 200 watt range.

Construction Suggestions

I added the jumper on the circuit side of the board from the end of the circuit run from R6, the POWER CAL potentiometer, to next to the ground run with the mounting hole on the side away from the connectors, to the end of the outside circuit run just on the other side of the same mounting hole. This jumps R8 and R9. The jumper goes from R6 to the red wire termination point.

I installed the trimpot at the end of the board with the CAL/NORM switch with the center lead to the end of S1 toward the connectors. The end terminal of the trim pot, away from the screw adjustment, goes to the circuit pad just inside the ground run. I added a piece of wire about 1 inch long to the trimpot lead and soldered the other end to the pad. The trimpot now

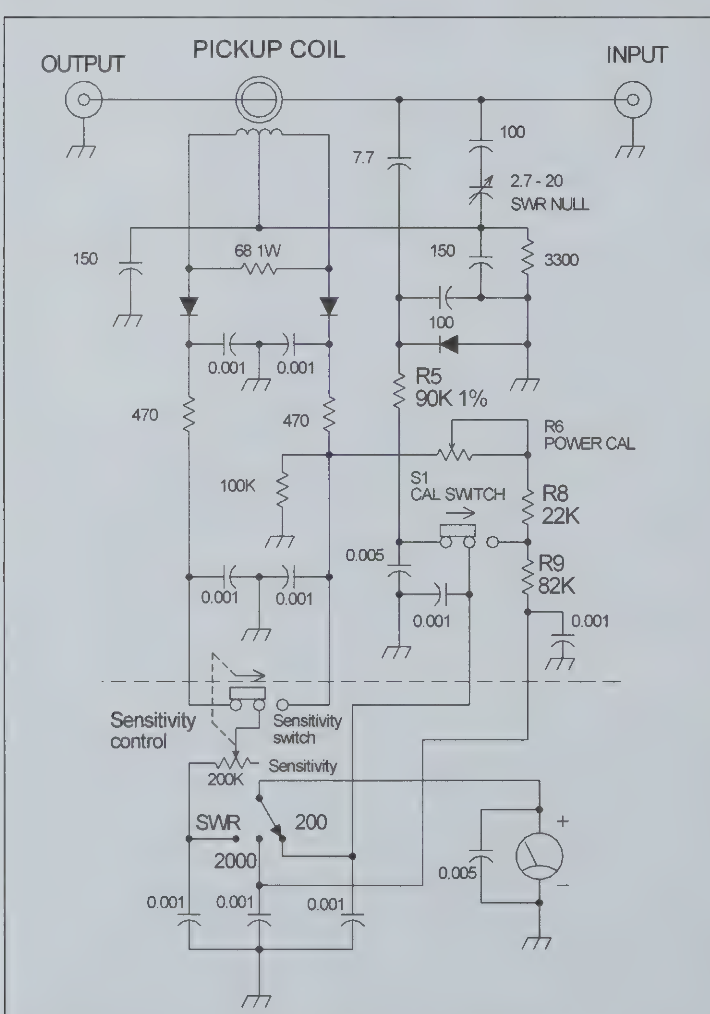


Figure 1—Schematic of the HM-102 (unmodified).

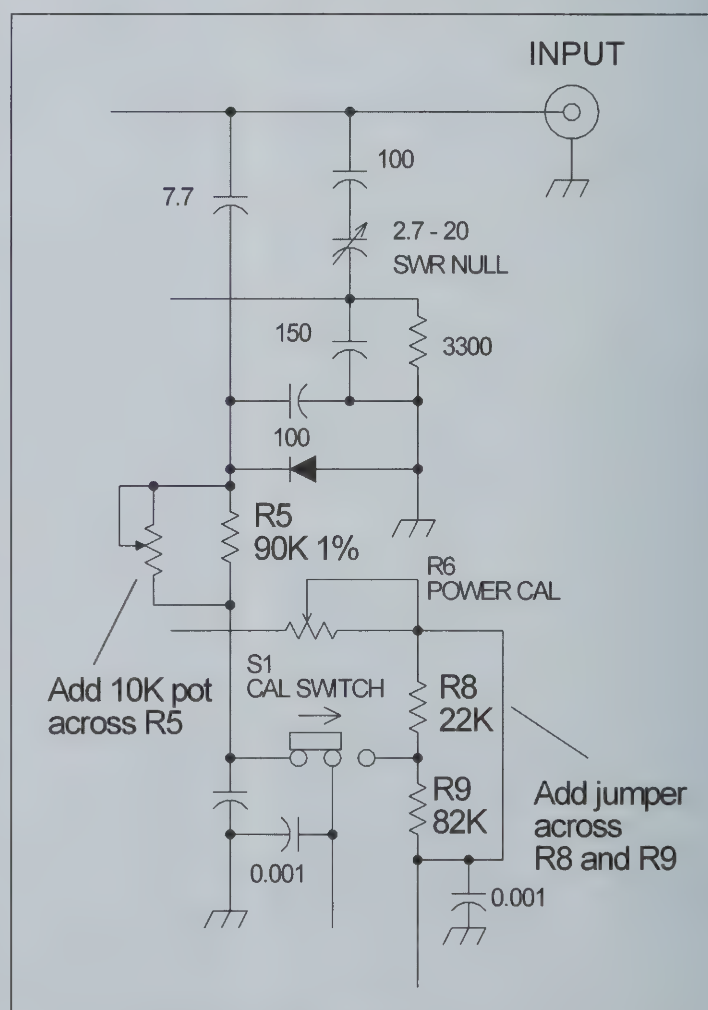


Figure 2—Details of the modifications for QRP operation.

Small changes to the HM102 can convert it into a QRP wattmeter. (This photo is the HM-2102 VHF version, which uses the same style cabinet and controls. Power ranges for the HM-102 are 2000 watts and 200 watts.)

bypasses R5, 90k.

The SWR function still operates normally but it takes at least 4 watts to get a full scale calibrate setting. At lower power it still will give a relative reading, which is good enough to let you adjust an antenna or tuner for minimum SWR.

—de W4BWS

●●

Have You Modified Commercial Equipment for QRP Operation?

If so, your fellow QRPers probably want to know about it! Write a description of your work, take pictures or draw sketches and send the material to one of the *QRP Quarterly* editors. They will let you know if it's a good idea, and help you turn it into a great article.

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QRP Contests

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Hello once again QRP contest enthusiasts. This issue of QRP Contests makes up for the sparse one last time. You'll find results from the Running of the Bulls, the Fall QSO Party, the Holiday Spirits Homebrew Sprint, and the Top Band Sprint. There are announcements for the Hoot Owl Sprint, Summer Homebrew Sprint, and Milliwatt Field Day. After each of these contests you can use the High Claimed Scores form at http://personal.palouse.net/rfoltz/arci/form.htm to send me your contest summary. Your log can be sent separately by e-mail or regular mail. Watch the claimed scores change each evening at 9 PM Pacific Time for two weeks after the contest by looking at http://personal.palouse.net/rfoltz/arci/highclm.htm. This web page contains only those results submitted using the web form above.

The QRP ARCI contests home page is http://personal.palouse.net/rfoltz/arci/arcitst.htm.

See you on the air!

Mark your Calendars:

Hoot-Owl Sprint
May 25, 2003

Milliwatt Field Day
June 28-29, 2003

Summer Homebrew Sprint
July 13, 2003

Running of the Bulls

The 2002 Running of the Bulls was held piggy-back on the ARRL Sweepstakes CW Contest on November 2, 3, and 4. The purpose of this contest is to get as many Q (QRP) entries as B (high power) entries in Sweepstakes. There are two options: Bulls or Matadors. Bulls attempt to call CQ as much as possible while Matadors use their S&P skills. Bulls get points by working other Q stations. Matadors get points by working Bull stations. Before the contest Bulls must register with the contest manager so that Matadors will know who to hunt for. Matadors need not register. 2002 was the third year of the contest. At the time I'm writing this (mid-February) the ARRL results are not out and I don't know if we achieved our goal of more Q entries than B ones. I do know that our piggy-back contest generated a lot of interest in Sweepstakes among QRPers.

The next Running of the Bulls will be November 1, 2, and 3, 2003.

Soapbox

WU9F—Great conditions...worked a total of 15 Q stations but only three Bulls. Still had fun. See you next year. **WA5BDU**—A fun test with great conditions. I worked about 14 hours; all S&P except for about 3 Qs. I had 348 Qs and 77 sections. CQing best late in the contest for QRP Bulls, it seems. **W8VE**—This is the third time I have run QRP during Sweepstakes. My best showing so far, working 445 contacts and 76 sections. Good activity from the Q folks. I worked 31 Q stations including (4) Bulls. **W5KDJ**—Very surprised at the limited number of Qs, thought there would be more. Test was a good one with excellent props in Houston. 7 MHz was open and quite for a change. **W2EB**—Lousy bands this year, but the QRP stations were about 15% in the log. Most I've ever seen in sweeps. Let's keep it up folks. **W1SA**—I had hoped to work more QRP stations. Alas in 122 QSOs I only worked 4 QRP stations and none of them were Bulls! Hope everyone had fun. **W1AMF**—Worked the contest for 14 hours on 20 meters only...had a blast **NK6A**—It was a battle of the running of the bulls and the running of my nose. Came down with a cold for the weekend. I didn't break 500Qs (my goal), however, I did make 327 Qs. **N9NE**—At 3 a.m. Sunday, I had a wonderful idea. So many of the Q stations I worked are not members of QRP ARCI. Perhaps they don't know about us. They should! **N7RVD**—393 raw QSOs, 70 sections 55020 points in just under 18 hours of operation. 43 QRP stations. I had computer problems and almost quit. See you next year!!! **NØSXX**—Fun contest...I worked close to the full 24 hours for the first time ever. Really great bunch of QRP ops out there. **KX7L**—Wasn't sure I was going to make a big effort this year when I started, but I got caught up in the excitement, and managed to pass last year's SS score in the end. Worked 19 "Q"s in all. **KIØII**—Started late, many interruptions and ended early...Many "Q" stations with big numbers. **K9IUA**—Managed only 12 hours. Sorry about that. Had in-laws in town. **K8HJ**—Heard none Saturday, but Sunday afternoon netted KØFRP, N9NE, and K7TQ. There appeared to be some

2002 Running of the Bulls

BULLS

Place	Call	Sec	Qs
1	NØUR	MN	78
2	NØSXX	CO	71
3	N9NE	WI	66
4	K7TQ	ID	47
5	N7RVD	WWA	43
6	W2EB	WNY	34
7	K4FB	WCF	31
8	NK6A	LAX	29
9	K1EV	CT	27
10	K7GT	EB	24
11	W5KDJ	STX	21
12	WP4JXD	PR	20
13	K9IUA	IA	19
14	AE4EC	NC	4

MATADORS

Place	Call	Section	Bulls
1	KIØII	CO	11
2	AD6GI	SCV	6
3	KX7L	WWA	5
4	WA5BDU	AR	5
5	W8VE	OH	4
6	K8HJ	MI	3
6	WU9F	WI	3
8	N2CQ	SNJ	1

QRM on the band, but the K1 mojo pulled through. Many thanks to those operators. **K7TQ**—My best SS yet. Made 400 Qs from 70 sections with 201 of them S&P and the rest CQing. Worked lots of Q stations (12% of my total). All around great fun. **K7GT**—Murphy stuck early: the laptop screen died just before the contest. All logging by hand. Dupe checking by guess/gosh. Put in about six hours. **K4FB**—Nice to see several Q stations with very high QSO #s. See you all again for SSB. **K1EV**—I'd forgotten how grueling full-length contests can be; last one was probably 30+ years ago. First time using computer logging and I think I'm hooked. Bands were great here in the East. **AE4EC**—Managed only about 12 hrs operating time due to unexpected requirements. **AD6GI**—My first SS as some could tell. Goal to break 100; quit at 202. Too long to sit. Oh, well! Next year. Thanks to all for their patience with my rookie operation. See you next year. (8% of my total were "Q"). Way to go folks!

2002 Fall QSO Party
Top Ten

1	N4BP	2,374,421	6	KØFRP	1,941,760
2	K7RE	2,340,600	7	W1XE	1,792,420
3	CK5ZX	2,324,000	8	KØFX	1,092,770
4	NØUR	2,294,649	9	N1RR	1,092,000
5	NØAX	1,971,430	10	WB8RTJ	898,576

Category Winners

Less than 250 mW	KN1H	216,435
10 meters only	WA9PWP	8,463
15 meters only	W3SE	233,877
20 meters only	K5FX	70,875
40 meters only	K9PX	347,753
80 meters only	K1EV	28,224

Teams

Aluminum Kings—N4BP, W4FMS, KØFRP, NØUR, K7RE = 9,753,182
GMCC Wattless 5—KØFX, W1XE, WØETT, KIØII = 3,644,130
EPA QRP—WB3AAL, N3AO, WA3WSJ = 992,856

Fall QSO Party

The Fall QSO Party for 2002 was held October 19 and 20. After a couple of years of moving dates, it was back to the traditional third weekend in October. As you found out, it was also the JARTS WW RTTY contest which made for another difficult year on 40 m.

The top ten has both familiar QRP calls and a few that might not be so familiar. As is usually the case, Bob, N4BP, topped the list. But wait, Brian, K7RE, at his new QTH in SD was right behind with a mere 1.4% fewer points. Brian used the LT1 gambit while Bob roared out at LT5. Maybe next time the student will overtake the master. CK5ZX is really none other than VE5ZX, a familiar call. We all recognize NØUR, Jim, and KØFRP, Al. NØAX is a call familiar to contesters outside of the QRP world. Ward writes the *QST* Contest Corral, has attended each WRTC either as a participant or a judge, and can usually be found near the top of just about any contest he enters. Nice to have him in our contest. W1XE, KØFX, N1RR, and WB8RTJ have not been in the top ten as often and I hope to see them there again. Actually I'd like to see them in the top ten right after K7TQ.

Last year I wrote "Take a look at K9PX in the 40m band only category. Jim has a respectable score of 213,528 points in 11.5 hours of operation on 40m. Rather than complain about the RTTY contest, Jim got on the air and operated! A tip of the contest manager's hat to you Jim." History has repeated itself. This year Jim scored 347,753 points which was more than last year's effort. Again, Jim, you are an inspiration.

For each contest I receive a handful of stories too long to put in the soapbox. In this issue I will take some space to share two of them with you. The first one is from WA1GWH, Gary Nichols, in New York who wrote "From deep left field: This year I operated 'QRO QRP.' That is, 75W out to a 90 ft center fed insulate wire lying on the lawn NE/SW. I am probably 15-20 dB down from a decent antenna, but gave myself a power multiplier of '1' to be safe. I am not a fast or competitive op but contacts were mostly easy. Great contest and my favorite of the year." I'm not sure what to say about this one, but it was too different to pass up.

The second one, more mainstream-QRP, appeared in full on the Fall QSO Party Soapbox web page, but is well worth repeating here. David Michael Kopacki, Sr., KF2EW, reported "What a great time we had! I worked 13 hours, 11 of those with my 10 yr. old daughter Ashley, KC2GDT. We didn't score anywhere near the top but I can't help thinking that we won in the 'fun' category! She worked about 16 wpm, copying better than I expected, and sent both by hand and by the computer. We were camping in the backyard and worked the contest among all the other weekend activities. She was having such a good time she didn't even want to go out for pizza after the soccer game! She wanted to go back home and work the last two hours of the contest instead. Yep, I was in Dad heaven! After the contest she asked me if she could work CW Sweepstakes by herself, since I will be out camping by myself for that contest. So she will be operating as KC2GDT in the lower ends of the novice bands. The highlight of the contest came after it was over. We were laying in bed, still camping out, and Ashley said, 'I can still hear CW in my head. Can you, Dad?' Yep, Dad heaven."

Hard to beat that story!

Soapbox

AD6GI—Wow! Tail end a contest sure ups the hourly rate. Thanks to all for your patience. **AE4EC**—K2 operated like a champ; best score ever in one of these ARCI QSO Parties. **AF4LQ**—All operating was S/P and had a lot of fun working some familiar and new calls. Hope to see more activity on 80m in the future and I look forward to all of the ARCI events. **AGØT**—Had a blast running as a single-band entry on 80m. Very relaxed pace. Was surprised I didn't hear all that much activity on 80, though. Still managed to

2002 Fall QSO Party

QTH	Call	Score	Pts	SPC	Power	Bands	Time	Rig	Antenna
AK	AL7FS	3640	52	10	LT5	20,15,10	1	K2	KT34A
AL	W4DEC	670355	895	107	LT5	80,40,20,15,10	16	K2, Argosy	A4S @ 70', 160m inv vee
	K4NVJ	18060	129	20	LT5	20	4.25	K1	Dipole
	K4AGT	9156	109	12	LT5	20	3	OHR-100	GAP Titan
AZ	NQ7X	80696	262	44	LT5	80,40,20,15,10	4	TS850S	3 el tribander + 40 m el
CA	W8QZA	311766	571	78	LT5	40,20,15,10	6.5	FT817	3 el tribander @ 30', 40 m dipole
	W3SE	233877	777	43	LT5	15	17	FT1000MP	A3 @ 30'
	K9GQ	201376	464	62	LT5	20,15,10	15	TS570D	Indoor trap dipole
	AD6GI	26271	139	27	LT5	20,15,10	2	K2	Dipoles @ 25 & 40'
	KA6SGT	10353	87	17	LT5	20,15,10	6	FT-ONE	3/8 wave vert doublet
CO	KØFRP	1941760	1517	128	LT1	40,20,15,10	20	TS850, TS120	Tribander, loops
	W1XE	1792420	1652	155	LT5	80,40,20,15,10	19		
	KØFX	1092770	1165	134	LT5	80,40,20,15,10	12.5	TS930S	Yagi, delta loop
	KIØII	758940	834	91	LT1	80,40,20,15,10	14	K2, Omni	E-W windom, N-S Zepp
	NKØE	472311	833	81	LT5	40,20,15,10	19	IC706MKIIG	G5RV
	KBØLUR	161280	384	60	LT5	80,40,20,15,10	7	K2	Vert
	NØTK	160552	376	61	LT5		6	FT817	Attic dipoles
	K1EQA	101850	291	50	LT5	40,20,15,10	9	IC746	Hustlers on chair on back patio
CT	K1EV	28224	192	21	LT5	80	7	K2	Inv vee
	W1AMF	20930	130	23	LT5	20,10	9	FT817	TH3 @ 35'
	KB1FKL	8085	77	15	LT5	40,20,15	2	K1	G5RV
DE	K3CHP	430500	750	82	LT5	80,40,20,15,10	24	FT817	HF6
DL	DK3RED	1260	30	6	LT5	15,10	1.5	K2	10 m vert
FL	N4BP	2374421	2081	163	LT5	160,80,40,20,15,10	24	FT1000MP	TH7DXX, dipoles
	K4KJP	33516	171	28	LT5	20,15,10	3.5	K2, Sierra	TA33jr @ 33'
	KG4FSN	29736	177	24	LT5	20	8	NW20	Dipole
G	G4MQC	28217	139	29	LT5	20,15,10	6.75	Argosy	W3EDP
GA	K4GT	218302	503	62	LT5	40,20,15,10	9.5	K2	Yagi, 40 m loop
	W4DU	39963	173	33	LT5	20,15,10	2.75	K2	Beam, 88' OCF
	K4IR	2800	50	8	LT5	20	1.5	K1	Vert
HI	KH6B	3500	50	10	LT5	20,15,10	12	K2	Vert 48' diamond @ 1 m
IA	KFØN	1650	22	5	LT250		2	TS830S	41' vert
IL	N9RY	68796	351	28	LT5	20	5.5	K1	Attic inv vee
	N9SDT	39900	190	30	LT5	40,20,15,10	2.8	TS2000	Force12-Yagi
	N9WW	24150	138	25	LT5	80,40,20,15	2	FT817	Multi band dipole @ 35'
	WB9MII	4389	57	11	LT5	40,20,15,10	3	FT817	Indoor HB joystick
	W9CUN	686	14	7	LT5	40	1	Delta 580	40 m horiz loop @ 8'
IN	K9PX	347753	1057	47	LT5	40	16	K2	80 m loop
	W9CSL	56448	252	32	LT5		8.5	OHR 100A	Inv vee
JA	JA2UFH	4620	66	10	LT5	10	6	FT850	Stacked 3 el yagis
	JR1NKN	63	9	1	LT5	15	1	FT817	Vert
KS	WBØSMZ	51744	231	32	LT5	40,20	3	Rock Bender, NC20, TS140S	Vert
KY	AF4LQ	109200	312	50	LT5	80,40,20,15,10	6.25	K2	130' endfed
	K4AVX	61824	192	46	LT5	80,40,20,15,10	2.5	FT817	80 m dipole
	K4YKI	56406	237	34	LT5	80,40,15		K1, 570DG	Zepp, loop
LZ	LZ2RS	9072	81	16	LT5	15,10	2	TS520X	2 el & 6 el yagi
MA	N1RR	1092000	975	112	LT1	80,40,20,15,10	15	TS850S	
	WZ1R	60	4	1	LT250		0.1	TS850S	HB 7 el 10 m beam
MD	N2US	382480	683	80	LT5	80,40,20,15,10	23	TS50	DX-88
	K3ESE	249368	584	61	LT5	40,20,15	9.5	K1	200' hunk of wahr @ 25'
ME	KØZK	411012	699	84	LT5	40,20,15,10		K2	Indoor doublet
MI	W4FMS	801752	1112	103	LT5	160,80,40,20,15,10	14	K2	160 m inv L, inv vee, dipole
	K8CV	503384	808	89	LT5	80,40,20,15,10			
	K8HJ	119427	363	47	LT5	40,20	9	K1	CF Zepp 160' @ 30'
	KC8LTL	49266	207	34	LT5	80,40,20,15,10		K1, K2	
	W8RU	8330	85	14	LT5	40	0.6		
MN	NØUR	2294649	1917	171	LT5	160,80,40,20,15,10,6	22	K2	Yagi, wire
	WØUFO	102319	311	47	LT5	40,20,15	5.5	FT840	3 el yagi, inv vee
	KØMAX	34540	157	22	LT1	20	6	Corsair	R7
	NØHRL	847	11	11	LT5	40,20,15,10	2	FT817	Attic dipole
MO	KØLWV	14100	94	15	LT1	20	3	TS520	GP
MT	AC7GM	15246	121	18	LT5	80,40,20	4	IC706	G5RV
NC	AE4EC	97636	317	44	LT5	40,20,15,10	10	K2	Inv vee, thorn array

QTH	Call	Score	Pts	SPC	Power	Bands	Time	Rig	Antenna
	WA4CIT	93632	304	44	LT5	40,20,15,10	8	K2	44' doublet
ND	AGØT	4970	71	10	LT5		8	FT817	HF-2V
NH	KN1H	216435	307	47	LT250	160,80,40,20,15,10	6	Omni	300' end fed
	W1PID	18228	124	21	LT5			FT900, SST	OCF dipole
	AB1AV	1260	30	6	LT5	80	5	HB binaural xcvr	140' end fed wire @ 30'
NJ	N2CQ	892324	1179	108	LT5	80,40,20,15,10	17.7	TS850S	TA33jr, dipole
	W2AGN	850325	1075	113	LT5		20	K2	KT34, 300' loop, dipole, vert
	KF2EW	426384	752	81	LT5	80,40,20,15,10	13	IC706	Windom
	K2JT	395241	649	87	LT5	160,80,40,20,15,10	8	TS130V, TS570D	Doublet
	W2JEK	36890	170	31	LT5	80,40,20,15,10	2.5	FT840	Dipole, GP, end fed hertz
NM	WD7Z	230384	484	68	LT5	40,20,15,10	4	IC735	Random inv L
	W5TTE	85813	299	41	LT5	40,20,15,10	10.25	Argo 509	CF 60 ft wire
	K5AM	35154	162	31	LT5	40,20	3		
NV	WD7Y	40572	207	28	LT5	20,15,10	5.5	K2	40 m doublet
NY	K2ZR	363300	692	75	LT5	80,40,20,15	11	DX60, R4B	550' CF Zepp, 450' EF, 144' delta
	W3SMK	66787	329	29	LT5	40	8	K2	40 m dipole
	W2QYA	45300	151	30	LT1	80,40,20,15	9	HW8	Inv vee
	N2JNZ	22040	116	19	LT1	40,20,15,10	8	Omni D	G5RV
	NT2W	15498	82	27	LT5	80,40,20,15,10	3.25	FT817	G5RV
	WA1GWH	5500	220	25	GT1	80,40,20	5	TS430S	90' CF on ground
	NS2P	5376	64	12	LT5	40,20,15	2.5	HW8	Dipole
OH	WB8RTJ	898576	1136	113	LT5	80,40,20,15,10	16	FT920	C4SXL, dipoles
	W8VE	54649	211	37	LT5	80,20,15,10	4.5	FT817, TR7	Buddy Pole
	K8NI	39277	181	31	LT5	80,40,20,15,10	3	IC756PRO	Vert, 2 el yagi
ON	VA3SB	521752	847	88	LT5	80,40,20,15,10	16		
	VE3WZ	29484	468	63	LT5	80,40,20,15,10		K2	DX-88
	VE3IGJ	17710	115	22	LT5	20,15,10	4	K2	Inv V
PA	WA3WSJ	456960	768	85	LT5	80,40,20,15,10	20	K2	TA33, 80 m dipole
	WB3AAL	455200	569	80	LT1	80,40,20,15,10	12.5	K2	HF9V
	K3WW	408030	670	87	LT5	80,40,20,15,10	6	K2	1/4 wave 80, 402CD, C3
	K3MD	256928	496	74	LT5	80,40,20,15,10	4	FT1000MP	C31XR
	N3AO	85050	315	27	LT1	40	6.5	NC40	Yagi
	KW3U	6391	83	11	LT5	40	2	OHR Explorer II	Longwire
PY	PY7FNE	14	2	1	LT5	10	0.1	QRP+	Dipole
QU	VE2DEQ	119070	378	45	LT5	40,20			
RI	K8ZFJ	127280	296	43	LT1	80,40,20,15,10	9	Argo 525	Quasi-horiz loop
SC	K4ADI	227129	457	71	LT5	80,40,20,15,10	10	IC735	Yagi, dipole
SD	K7RE	2340600	1660	141	LT1	80,40,20,15,10	23.75	K2	80 m horiz loop, 2 wire vee beams
	WØRSP	779821	1103	101	LT5	40,20,15,10	12.5	GQ20, Argo 505, 515, Sierra	30m dipole
SK	CK5ZX	2324000	2075	160	LT5	80,40,20,15,10	21	IC736	C31XR, EF240S, vert
TN	K4BX	169785	441	55	LT5	80,40,20,15,10	15	K2	135' doublet
	NU4B	158368	404	56	LT5	40,20,15,10			
	N4QZU	4284	51	12	LT5	20	1	K1	MAV5 vert
	WA4AA	525	25	3	LT5	20	1	K1	550' loop
TX	W5KDJ	897250	925	97	LT1	40,20,15,10	14	Sierra, K1	PRO-57, DX-88
	W5TA	751072	958	112	LT5	40,20,15,10	17	TS430S	HF-2V, HB 5/8 wave 20 m vert
	KIØG	221850	435	51	LT1	20,15,10	11		
	K5FX	70875	189	25	LT250	20	6	Argosy	20 m dipole @ 25'
	K5JHP	13965	95	21	LT5	40,20,15	2	K2	TA33jr, dipole
	K7MA	11200	100	16	LT5	20,15	3	FT817	MP1
UT	W7TU	641900	917	100	LT5	40,20,15,10	15		
VA	K4UK	260372	547	68	LT5	80,40,20,15,10	11		
	N4ROA	110124	342	46	LT5	160,80,40	5	K2	450' loop, 160 m inv L
	KK4R	58443	253	33	LT5	80,40,20,15	5	FT817	20 m inv vee
WA	NØAX	1971430	1439	137	LT1	80,40,20,15,10	20	FT1000MP, FT847	C3, 2 el Gem Quad', 40-2CD
	NG7Z	283354	519	78	LT5	80,40,20,15,10	8.5	ICK756	CF 40 m zepp
	WA7NCL	176638	407	62	LT5	80,40,20,15,10	5.5	TS870	Vert, horiz vee
	WA2OCG	50372	257	28	LT5	20,15,10	6	FT817	R7
	N7RVD	32319	171	27	LT5	80,40,20,15,10	2		
WI	N9NE	788900	980	115	LT5	160,80,40,20,15,10	10	K2	260' doublet, tribander
	WA9PWP	8463	93	13	LT5	10	2.5	IC756PROII	Windom & vert
WV	WF8X	128688	383	48	LT5	80,40,20,15,10	7	TS570G	R7 & G5RV
	K8KFJ	30800	176	25	LT5	80,40	3	IC706MKIIG	14AVQ, dipole
XE	XE2/EA5XQ	3010	43	10	LT5	20,15	2	FT817	Magnetic loop

add several new states on 80, including CT. **AL7FS**—I was pleased that at least three Alaska stations were on during the contest. KL7IKV,AL7OK and I are all members of the new Alaska QRP Club. **DK3RED**—A lot of fun and some QRPer in my logbook! **KØFRP**—40 and 80 was my down fall. 40 RTTY was a killer, and I should have tried longer and harder on the low bands. My 1 watt was not enough there. Glad to see 10/15m open for most of the day. **KØFX**—Have not operated this contest for a few years, but it's still as fun as ever. A lot of the same stations still there. First time to use 10 & 15m, lots of loud sigs there. **K2ZR**—Operated my '60s station gear: DX60 with xtals & HG10B VFO along with a Drake R4B. Had a great time! **K3CHP**—It was fun to operate from new QTH in Delaware. **K3ESE**—Loads of fun, would have spent more time if I knew I would be amassing kilopoints. Next year hope to be on two more bands for more total time. **K3WW**—Not much time, bounced between QRP ARCI and WAG contests. **K4AVX**—Enjoyed the contest...40 meters was a mess with all the RTTY QRM from the other contest. Used FT-817 and 80 meter dipole. **K4BX**—Big sigs from N4BP, CK5ZX, W1XE, KØFX...best surprise was KH6U on 10 mtrs. Tnx to all for the 100 fun contacts. **K4UK**—It was great fun again and I really got a kick out of working KH6U on two bands and being called by JW5WU on 10 Meters. **K5FX**—Between the packet above and the county hunters below I was surprise how well I could work folks at 240 mW out. **K7MA**—First contest for me in about 11 years. I really need a better antenna. I enjoyed getting back on the air after a 10 year lapse, though **K7RE**—Bettered, by a reasonable amount, my all time score in both SPCs and total points. I am a happy camper. These wire antennas sure work, and they are MUCH cheaper than towers or aluminum beams. **K8CV**—Fun working around hi power RTTY stations, not! **K8HJ**—Had a great time in three widely spaced sittings. 40 was terrible at night due to RTTY, but fine the next morning. 20 was great, with lots of stations. Thanks to all who worked me! **K8NI**—First ARCI. Sigs were good. **K8ZFJ**—Loop antenna works as good if not better than the G5RV...I was amazed...another fun weekend. **K9PX**—The JARTS RTTY Contest was a bear on 40m Saturday night. My thanks to the guyswho stuck with the band anyway. **KA6SGT**—My first QRP specific contest. All very pleasant ops. Next time, I'll write VBA in MS Excel. Be back next time. **KBØLUR**—Always need a better antenna. 15M my best band. KC2GDT. We didn't score anywhere near the top but I can't help thinking that we won in the 'fun' category! **KFØN**—Output power to 10 milliwatts and made just 6 QSOs. Not bad, though, for over 70,000 miles per watt for each QSO! I'm going to try that again in the Spring. **KG4FSN**—Condx were not so good here in south FL but had a lot of fun. the dipole in my living-room worked FB for what it is. **KH6B**—Enjoyed the "Party" at our camp site: Namakani Paio Campground, Hawaii Volcanos National Park. It's 1/2 mile from the rim of Kilauea Volcano that has been erupting since 1983. 72 and Aloha! **KIØG**—After all these years, I finally have a vertical in salt water. It does help. **KIØII**—Signal strength seemed down but quite a bit of activity. **KK4R**—K4AEN and I (KK4R) sailed out of Yorktown and WA4CHQ sailed from Gwynn to meet in the East River off Mobjack Bay. We rafted the boats and put up a 20m inverted V on Tom's boat. **NØAX**—The results were excellent, surpassing the old WA record set down at W7RM's super-station by N7OU and the posted 20-15-10 record set by W5VBO. **NØHRL**—Pretty small effort this year, but fun anyway. **NØTK**—Spent most of the weekend painting and planning for next stealth antenna. **NØUR**—A pleasant surprise how good the bands were, almost more Qs on 10 meters than 40. **N1RR**—First ARCI-QRP event as a member. Joined after enjoying many QRP contest before. This one was great fun. Station is still under construction. No 160M antenna. 20M antenna is fixed on EU. **N2JNZ**—700 mW was a blast!!!! CK5ZX on 3 bands , N4BP on 2 bands great test but too much RTTY on 40m. **N2US**—My first serious operation in a QRP ARCI contest since the '60s. Enjoyed it! **N4BP**—Good condx and participation on 10M for a change. **N9NE**—Simultaneous "competition" included RTTY and SSB signals, the IL Test, and a TV set in the shack set to the World Series and the Packer-Redskin game. Thanks for the phun! **N9WW**—Not much time to operate but condx were good and QSO Party was as much fun as usual. Thanks to the organizers. **NG7Z**—First time in this contest. Bands were not that good here. Didn't have much time to participate. Had to work on Saturday. See you next spring. **NKØE**—Thanks to all for the great contest! **NQ7X**—Only got about 4 hrs in but fun as always. Had trouble making contacts Sun p.m...thought equipment problems but guess it was just band condx. Tried to QSY to 21 for N4BP but couldn't connect...strange. **PY7FNE**—Dear Friends: Sorry, but I only worked one ham at 28 MHz. G4MQC. Next time I'll try to do the best. **VA3SB**—I did not spend as much time as I wanted on the contest due to other family commitments however had a wonderful time. We have a great bunch of operators out there. **VE3WZ**—My first ARCI QP & enjoyed it very much. Will probably be in the next one. **WØRSP**—Great time! Moved into the new age with software logging and after 8 hours and CP wrist, I programmed my test "CQ" into the keyer. Boy, what a life! **W1AMF**—First ARCI contest. **W2AGN**—Whines: #1. RTTY on 40M! #2. People who don't zero your frequency! **W3SMK**—Had a great time! Was glad to be able to work the West Coast on 40m with the K2 and a dipole. Hope to see you all in the Spring! **W4DEC**—Condx not so good this QTH. Had to quit early due to health problem. Wonder if I worked any rock-mites? W4FMS—Great condx this year. See you in ARRL SS. **W5KDJ**—Really great contest, 28 MHz finally agreed to open up a little bit. Running a new Sierra KC1 on 28 MHz, Elecraft K-1 on other bands. Antenna is a Mosley PRO-57, DX-88 trapped vertical on 7 MHz. **W5TA**—This was really a fun contest. Family obligations kept the air time to 17 hours. Some of the 100 and 200 milliwatt stations put out a really good signal. CK5ZX was loud on all bands (40-10). **W7TU**—Too many BIG GUNS and not enough little pistols! Good show of participants and lots of fun! Not much on the low bands here. **W8QZA**—My friend NØKE (Phil) got me into this contest. I downloaded K7RE's freeware logging program, and it worked fine. Lots of fun! **W9CSL**—Thanks all had a good time, wanted to see what could do with 3 watts & low profile short inv vee on 40 meters & was pleased, however, would like to see contest moved off the rtty contest weekend. **WA3WSJ**—I had a real blast operating this contest. 40M was all noise! **WA7NCL**—Great contest

with a lot of participation. Polite and skilled operators. I am considering becoming a member. **WB3AAL**—Did not get a chance to work the entire contest but I still had a Blast. Especially working 2 KL7s and 12 European DX stations on 15 meters. I even worked a GU4 station with 900 mW. **WB8RTJ**—Got a late start due to a golf outing but lots of fun. Am sure everyone had a ruff time on 40m with the very strong rtty sigs. Look forward to next one. **WD7Z**—Just operated a few hours as I had time. Lots of fun. **WZ1R (N1RR op)**—Found YU7BCD at 18:30z on 10M CW @ S9+30db. My report at 1 watt was S9+10db. Tried 50 mW successfully with a 549 report. He could not copy me at 5mW. **XE2/EA5XQ**—It has been my first QRP ARCI test. It was really amazing above all because from my current QTH (Monterrey, Mexico) there is a lot of electrical noise and the signals are difficult to be copied. **WB9MII**—Time was limited but I enjoyed the contest. **WA9PWP**—I heard 10m activity and couldn't stop! **K5JHP**—Very FB contest. **W2JEK**—Nice contest, but only a few hours to operate. **KW3U**—RTTY killed my plan of night operating, but after working WA4DOU a UT3 called for a QSO. **K4IR**—My first ARCI contest! **K8KFJ**—Decided early on to do the LOW BAND category. It turned out to be a bad decision. The RTTY guys really tore up 40 m with big time signals. Only a 3 hour effort this time and a learning experience. **K9GQ**—Good conditions on 10 and 15. **K4YKI**—Second time entry. On the plus side, good band conditions for the most part. Had a good run, considering I don't have a computer logging system. On the negative side, was the RTTY. **WA2OCG**—Used 12V, 4.5 amp battery power source. The FT817 really can do the job! **G4MQC**—10 m best band. Impressed with W3EDP. Such a simple wire antenna. WAS score QRP = 48. 2 way QRP = 31. **K1EV**—Great to hear activity on 80 for a change, so decided to stay there for the time I had available. **KB1FKL**—My first ARCI test and first QSOs with my K1... fun! **KØMAX**—Great fun! **VE2DEQ**—Second time on the contest and enjoyed it very much. **W8VE**—I operated the contest in conjunction with radio demonstrations.

Top Band Sprint

The 2002 Top Band Sprint was held December 4 for any 4 consecutive hours between 6 PM and 6 AM local time. This was the second year of this contest. Twenty-seven folks sent in reports which was down just a bit from last year's 33. On the good side, scores were way up. N4ROA, Dan, topped out with 41,832 points which left the top score from last year of 16,758 in the dust. There were no mixed mode entries and no SSB entries.

2002 Top Band Sprint
Top Three

1	N4ROA	41,832
2	W4FMS	34,154
3	KF9D	34,293

Category Winners

Less than 250 mW	W3TS	19,110
Less than 1 W	K1HJ	360

Take a quick look at the winner of the Less Than 250 mW category. There is ol' W3TS again.

In 2003 the contest is scheduled for December 3.

Soapbox

WB6BWZ—Yaesu FT-817 to 5 MHz OCF 28-ga insulated wire stealth antenna

2002 Top Band Sprint

QTH	Call	Score	Pts	SPC	Power	Mode	Time	Rig	Antenna
AZ	AC7A	7560	90	12	LT5	CW	2.5	K2	45' top loaded vert
CO	KIØII	9184	82	16	LT5	CW	4	K2	Inv L
FL	N4BP	2205	35	9	LT5	CW	2	K2	Inv vee
GA	WB6BWZ	315	15	3	LT5	CW	2.6	FT817	OCF @ 40'
HI	KH6B	14	2	1	LT5	CW	2.5	K2	284' sloping diamond loop
ID	K7TQ	5390	77	10	LT5	CW	3	K2	Inv L
IL	KF9D	34293	213	23	LT5	CW	4	TS930S	Inv L
KY	AF4LQ	4200	60	10	LT5	CW	2	IC706	End fed L
MA	K1HJ	360	12	3	LT1	CW	2	IC534	80 m dipole
MI	W4FMS	35154	186	27	LT5	CW	4	K2	3/8 wave inv L
	W8RU	9660	92	15	LT5	CW	1		
MN	WØUFO	3150	50	9	LT5	CW	2	FT840	Zepp
MO	WØCH	12880	115	16	LT5	CW	4	K2	700' wire
	AE9B	1960	20	14	LT5	CW	1		
ND	AGØT	2646	54	7	LT5	CW	4	FT817	HF-2V
NJ	W2AGN	1974	47	6	LT5	CW	1	Argo II	Inv L
ON	VE3FAL	7420	106	10	LT5	CW	2	FT817	Dipole
PA	AA3SJ	24080	172	20	LT5	CW	3	K2	Vert T
	W3TS	19110	98	13	LT250	CW	2	HB xcvr	1/8 wave T
	W3ZMN	735	21	5	LT5	CW	2	K2	Dipole
SD	K7RE	15260	109	20	LT5	CW		K2	Top loaded 44' vert
TN	KW4JS	2940	42	10	LT5	CW	2	K2	Dipole
TX	N5TW	23667	161	21	LT5	CW	3.5	FT1000D	4 sq
VA	N4ROA	41832	249	24	LT5	CW	4	K2	Inv L
	K4UK	6468	84	11	LT5	CW	3		
WI	N9NE	23142	174	19	LT5	CW	4	K2	600' loop @ 25'
	WA9TZE	12810	122	15	LT5	CW	1.3	TS870	Slopper @ 40'

up 40 feet in trees next to I-75 in downtown Atlanta industrial area. Band condx: Too noisy for QRP SSB. SPCs: VA, MI, IL. **WA9TZE**—Nice to hear ops using 160m. Very nice contest and like the any 4 hrs out of 12 hrs as the format. It gave a lot of leeway to fit it in the schedule. W4FMS—I hadn't had much of a chance to play with my 3/8 wave Inverted L. It's got about an 85 ft vertical run up a very tall white pine tree. I worked the contest 0130Z to 0530Z which seemed to be about right here as far as activity. **W2AGN**—BAD QRN! Sounded like arc welder. Noise blanker helped, but still headache time. **WØUFO**—Lots of fast QSB. All sigs weak and in the noise. Thanks to all that participated. **WØCH**—This was my first contest effort on 160 meters. Haven't worked 160 seriously for many years and was very interesting. Lot of familiar calls heard on the band. Thanks to everyone for digging out my weak signal. **VE3FAL**—Always have fun on 160 QRP, can't wait for the next test, thanks to all for being on the band Next year the antenna goes up higher, or maybe full wave loop....I still have 10 acres to plant wire on. **N9NE**—Weak signals with long QSB fades. Heard nothing from the Rockies westward, New England, or the Florida Peninsula. Signals seemed to strengthen toward local midnight (0600z) with VE3FAL (ON), K7RE (SD), and N4ROA (VA) rising one or two S units from our earlier contacts. **N5TW**—W5TA and I used this as a shake down cruise for the ARRL 160M contest albeit about 25 dB lower power. We had fun but sure messed up by starting late...no body called in the first half of the last hour so we bagged it. **KIØII**—Stronger out of state QRP signals from WØCH, N5TW, K7RE, WA7LNW and AC7A if the morning after memory serves correct. Without a doubt, the new inverted-L outperforms the NVIS 80 meter windom. **KH6B**—I worked every station I heard during the Sprint. Bryce KH6AT answered my CQ. Our exchange 599/599. **KF9D**—Fun contest to "warm up" for the ARRL 160m contest the following weekend. **K7RE**—Antenna is top loaded 44 foot vertical, 5 top hat wires, and 80M dipole used for loading. Radials 1600 sq. feet of chicken wire, laid out as spokes on a wheel from the base. Base is at ground potential, fed from top of vertical. No tuners or traps used. **K4UK**—Guess I should have waited until later in the evening, because signals were not very strong. Also some of the non-members didn't understand that I needed their power and state for an exchange. **AGØT**—This really is a fun and challenging contest! It's also a hard one to figure out which four hours one is going to operate for. The band can be pretty fickle. 0200-0600Z or 0300-0700Z seems to be about the best overall, IMHO. Tough to sit up much later and be worth a hoot at work the next day. **AE9B**—Fun contest but not enough time to operate. Thrilled to work FM5GU on 3 watts. **AA3SJ**—Lots of QSB. No real west coast openings. **N4ROA**—Had to really dig, but that's what makes it fun...big challenge.

Holiday Spirits Sprint

The Holiday Spirits Sprint was held December 1, 2002 with a solar flux of 149. This year entries totaled 60 and like the Top Band Sprint, scores for the top three were higher than the previous year.

Worthy of note in this contest was Mike Michael, W3TS, who entered in the Less Than 250 mW category from Pennsylvania. With his homebrew CW transceiver Mike made QSOs with 34 states and 2 provinces. Antennas used for this effort were a 1/8 wave tee for 160 m, 80 and 40 m inverted vees at 60 feet and 2 element yagis at 52 feet. A great showing of what very low power can do.

2002 Holiday Spirits Sprint Top Three

1	N4BP	561,382
2	VE5ZX	468,188
3	W3TS	332,775

Category Winners

Less than 1W	W5KDJ	240,400
20 meters only	W5TA	67,944
40 meters only	K9PX	118,701
High-bands	NK6A	55,579

Many of you have probably worked KØZK, Arn Olean, in Maine since he is a frequent contest participant. He wrote "I spent all day Saturday getting ready for this. I was planning on setting up at Parsons Beach, Wells, Maine with salt water on all sides. I had to get lighting so I could see to log, warm clothing, food and drink, my special KØZK portable vertical and all the other stuff. When I got to the beach, it was 28 degrees F and the wind was blowing at 50 MPH steady. When I removed my gloves to tie my shoes, I felt that wind-chill set to work fast. I knew then that setting up the big vertical was out of the question. I would be frozen solid just when I was supposed to start operating CW with a paddle. It just would not work, and/or I would end up in the hospital with either frostbite or hypothermia. So, at five minutes before the contest started, I packed it all in and started to drive home to North Lebanon, about a 45 minute drive. Of course, I then had to reassemble the station, most of which had been dragged to the beach. I did well to make my first contact at 2057Z and sure was proud of myself for not being in the hospital at that point." Another great contesting story!

In 2003 the contest is scheduled for December 7.

Soapbox

AA3WI—Real rough on 15 and 20. Guess everybody else was using beams. Moved to 40 and made the bulk of my contacts. First time I worked with 1 watt. Thanks for the great contest! **AD6GI**—20M + 15M worked best here. QSY'd to 10M for K4BAI, but band was dead here. Tnx to all for another great Sprint. **AE4MZ**—Dusted off the SW-40 for first time in years, clamped the mobile whip on chain link fence (effectively a Dummy Load?) and managed to make one contact. I'll be back with a better ant next time. **JRØBAQ**—Too tough condition to make 2-way QRP contacts with stateside stations from Japan. **KØEVZ**—This was truly a fun contest. Got into it a bit late, due to a delay returning from church. Bands sounded pretty good overall, though 20 Meters simply died with about 30 minutes remaining. **KØVSV**—Xmitter was a single 6L6 copy of the Ameco AC-1. My apologies to those I may have QRM'ed but with only one crystal I had no way to QSY. **K1HJ**—Another enjoyable ARCI contest. Appeared to be a good amount of activity on the upper bands but not so much on 80. I'm curious how others did on that band. **K4BX**—Another fun slow paced contest! Thanks for the fun. Big sigs from N4ROA and K9PX on 40 meters. Heard KH6B Dean on 15 but no luck. **K4UK**—Another fun contest! Made contacts on five bands this time. Thought I had worked Alaska when KL7H/C6A called me on 20 Meters, until I heard the /C6A on the end of his call.—HI! **K5ZTY**—Good way to end a

QTH	Call	Score	Pts	SPC	Bonus	Power	Bands	Time	Rig	Antenna
AZ	KJ5VW/7	26786	109	22	10000	LT5		3	K2	20 m vert
BC	VE7ASK	34020	162	30	0	LT5	20,15,10	2.5	FT920	2 el hex beam
	VE7NI	25160	144	20	5000	LT5	20	4	TT1320	
CA	NK6A	55579	187	31	15000	LT5	20,15,10	2	HB xcvr	
	AD6GI	54104	168	29	20000	LT5		4	K2	40 m dipole @ 40'
CO	KBØLUR	107016	312	49	0	LT5	40,20,15,10	4	K2	Dipole @ 23'
	KIØII	11370	65	14	5000	LT5	20,15,10	0.75	K2	EDZepp @ 25'
	KØYGY	9620	55	12	5000	LT5		4	K2	85' house gutter
CT	N1EI	76250	150	25	20000	LT250	80,40,20,15	4	OHR500	88' doublet @ 50'
FL	N4BP	561382	774	99	25000	LT5	80,40,20,15,10	4	K2	TH7, dipoles
	K4KJP	19996	84	17	10000	LT5	20,15	2		
GA	K4BAI	196350	425	66	0	LT5	40,20,15,10	4	FT1000MP	TH6DXX, dipole
	WB6BWZ	27846	153	26	0	LT5	40,20,15,10	3.5	FT817	Wires
	W4JBM	5014	2	1	5000	LT5	40	1	TT1340	G5RV
HI	KH6B	10560	20	4	10000	LT5	15,10	1	K2	284' sloping diamond loop
	KH6HE	1568	32	7	0	LT5		1	Scout	3 el tribander
IA	KØVSV	4240	40	8	2000	LT5	40	1.6	6L6 HB xmtr	
ID	K7TQ	206725	485	55	20000	LT5	40,20,15,10	4	K2	C4S @ 50'
IL	K9VON	4200	60	10	0	LT5	40	1.5	Omni VI+	80 m loop
	WB9MII	2058	42	7	0	LT5	40,20	1.5	FT817	HB indoor joystick
IN	K9PX	118701	439	37	5000	LT5	40	3.5	K2	80 m loop
JA	JRØBAQ	126	9	2	0	LT5	20	1	TS440V	DJ2UT beam
KY	WD8JCR	6825	75	13	0	LT5	80,40,20,15			
MA	K1HJ	91050	203	35	20000	LT1	80,40,20,15	4	K1, HB xcvr	80 m dipole @45'
MD	KB3WK	116300	321	30	20000	LT1	40,20,15,10	4	K2	3 el beam @ 40'
	AA3WI	30660	87	18	15000	LT1	80,40,20,15	4	Sierra	Long wire
ME	KØZK	79787	219	39	20000	LT5	40,20,15,10	3	K2	Vert
	W4ZGR	20005	65	11	15000	LT5	40,20,15	2	HW8	TA33 @ 70'
MI	KC8LTL	41905	115	21	25000	LT5	80,40,20,15,10	3.5	K2	
MN	NØUR	75606	222	39	15000	LT5	40,20,15	1.5	K1	Yagi, wires
	WØUFO	72160	240	37	10000	LT5	40,20	1.6	K1	Inv vee, TA33
MO	KØLWV	23275	133	25	0	LT5	40,20,15	2	TS520	Dipole, Zepp
ND	KØEVZ	106292	362	38	10000	LT5	40,20	3		
NH	W1PID	24112	112	18	10000	LT5	40,20	2.3	SST, DSW	OCF dipole
NJ	W2AGN	182460	363	60	30000	LT5	160,80,40,20,15,10	3.5	K2	KT34, dipole, 300' loop
	W2JEK	21552	72	13	15000	LT5	40,20,15	2	TT1315, OHR500	Dipole, GP
NM	WA7LNW	13232	84	14	5000	LT5		1	K2	Inv vee @ 30'
OH	AB8FJ	18276	52	9	15000	LT5	80,40,20	1.75	SW-80,SW-40,SW-20+	Random wire
OR	KI7Y	43428	188	33	0	LT5	40,20,15,10	3		
PA	W3TS	332775	367	55	30000	LT250	160,80,40,20,15,10	3.5	HB xcvr	T, inv vee, yagi
	W3ZMN	37556	114	22	20000	LT5	80,40,20,15	3	K2	
SD	K7RE	311781	571	73	20000	LT5	40,20,15,10	4	K2	80 m loop, Vee beam, 2 el beam
SK	VE5ZX	468188	727	92	0	LT5	40,20,15,10	4	IC736	C31XR/EF240s, vert
TN	NY4N	198009	449	63	0	LT5	80,40,20,15	4		
	K4BX	53570	190	29	15000	LT5	40,20,15,10	4	K2	135' doublet
	KW4JS	45116	138	26	20000	LT5	40,20,15,10	3.5	K2	Multiband loop
	N4LT	22138	102	17	10000	LT5	40,20	2.5	K2	Vert
TX	K5ZTY	282143	513	73	20000	LT5	40,20,15,10	4	K2	C4S
	W5KDJ	240400	380	58	20000	LT1	40,20,15,10	4	Sierra, K1	75' long wire, PRO-57B
	W5TA	67944	281	32	5000	LT5	20	4	Red Hot 20	5/8 wave vert
	KIØG	37758	174	31	0	LT5	20,15,10	3		
	AE4MZ	5050	5	1	5000	LT1	40	1	SW-40	7' mobile whip
VA	N4ROA	297986	527	74	25000	LT5	80,40,20,15,10	4	K2	2 el quad, 450' loop
	K4UK	162060	356	55	25000	LT5	80,40,20,15,10			
	KG4PUG	51597	273	27	0	LT5		4	TS430S	Inv vee @ 30'
	KK4R	43680	195	32	0	LT5	40,20,15,10	3	TS940	130' dipole
	WB4JJJ	38124	182	26	5000	LT5	20	3	K2	Carolina windom
WA	AC7MA	25458	83	18	15000	LT5	40,20,15	4	HB xcvr	End fed wire
	N7RVD	15420	20	3	15000	LT5	20,15,10	0.25	K2	Tribander @ 45'
WV	WA8WV	93975	195	27	15000	LT250	40,20,15	2.4	K1	EF420/240, 4BA

Table title: **2002 Holiday Spirits Homebrew Sprint**

holiday weekend. Good conditions on all bands here and lots of member numbers to work. Got to work the contest manager on 2 bands. Thanks for scoring this one again Randy. **K7RE**—This was a good one. Tried QSYing to other bands upon request, and mostly that tactic worked out fine. All ARCI contests are fun, maybe some are more fun than others. **KBØLUR**—10M not so good here in CO but 15/20 excellent. 40M very noisy. First time using TR logger. Fun time. **KB3WK**—Nice contest. Enjoyed the pace. **KG4PUG**—The higher bands were noisy so I decided to go Single Band on 40m. I'm glad that I did. Worked 66 stations in 27 SPCs, all with an inverted vee at 30ft. I had a blast. **KH6B**—WX7R had a whopping 599 signal into Hawaii. I started on 10, then moved to 15 for my one-hour participation. **KH6HE**—Many signals heard on 10 & 15, but, unable to break thru. Worked JA6PA with ant bearing stateside. **KIØII**—Gee, thank goodness for bonus points! Should have tried another band or two;..Hi. Good activity on the bands but there usually is when you first get one. Was fun! Thanks. **KJ5VW/7**—Another great contest. My apologies to all who tried to copy my broken key during first hour. Enjoyable afternoon spent on the patio working some great QRP sigs. **KK4R**—I just got a TS 940, and all my homebrew stuff is still pushed out of the way so the shack can be reorganized. The 940 did well, but you can't beat the fun of using the homebrew rigs. **NØUR**—A got a good hour and a half in before my wife caught me. Lots of stations, wish I could of hung in there longer! **N1EI**—Bands were in nice shape. Got our contest manager, K7TQ, in the log again. Thanks Randy for a great contest! **N4BP**—Great condx and participation! Worked quite a few stations on four bands. Not enough people checking 10M as usual. Fun sprint! **N7RVD**—Great contest. A real blast. Thanks to all. **VE7ASK**—Plenty of fun...stations all bundled up around 060 makes for QRM even with QRP. Some QRPp signals were tough to work but enjoyed them a lot. **W1PID**—This was a lot of fun. I wish I had some homebrew gear on 15 and 10. I've got a feeling they were active. Thanks to all for a great sprint. **W2AGN**—FINALLY made a Sprint QSO on 160! Made for a 6 band bonus. Conditions good on lower bands, so-so on 15 and 10. **W4JBM**—Only had an hour to operate. Spent half of it calling CQ, but finally raised someone and had a nice QSO. Quality, not quantity. My first contest and it was a blast! **W5KDJ**—Great contest, had lot of fun working everyone again. **W5TA**—Conditions poor at beginning of contest. Improved toward end. Noise level high at my QTH. **W5TQ**—My apologies to all who called that I could not copy, especially KL7?/C6A. All in all a very enjoyable contest. Nice to hear some now familiar calls. This go was 20m only with my little "Red Hot." **WA7LNW**—Operated contest from Edgewood, NM this year as I am now working for Sandia National Laboratories (so we have two radio operating QTHs now NM and UT). Excellent band conditions. **WB4JJJ**—Lots of noise here...band was long; worked very few locals. **WB6BWZ**—Yaesu FT-817, 5 watts, to 28-ga insulated wire 5-MHz OCF stealth antenna up 40 feet in trees next to I-75 in downtown Atlanta industrial area. **WB9MII**—I won't win but I had an excellent time 72. **WD8JCR**—Wow lots of stations were taking part this year. At times the QRM was really bad, this is neat for a QRP contest. I was also amazed at the speed of some of the operators. I wish we could all slow down a bit, we might not have to repeat so much. **KØZK**—Conditions were not great, but it is always fun to get on in a QRP event, so I was having fun with the homebrew sprint. **KØLWV**—Great contest. **WØUFO**—First contest using K1. Only managed a short time to operate, but had fun. **N4ROA**—Thanks for all the fun.

Contest Announcements

2003 Hoot Owl Sprint

Date/Time:

May 25, 2003, 8:00 PM to midnight Local Time. CW HF only.

Exchange:

Members—RST, State/Province/Country, ARCI member number;

Non-member—RST, State/Province/Country, Power Out

QSO Points:

Member = 5 points; Non-member, Different Continent = 4 points; Non-member, Same Continent = 2 points

Multiplier:

SPC (State/Province/Country) total for all bands. The same station may be worked on one band for QSO points and SPC credit.

Power Multiplier:

0 - 250 mW = x15
250 mW - 1 W = x10
1 W - 5 W = x7
Over 5 W = x1

Suggested Frequencies:

160M	1810 kHz
80M	3560 kHz
40M	7040 kHz
20M	14060 kHz
15M	21060 kHz
10M	28060 kHz

Score:

Points (total for all bands) x SPCs (total for all bands) x Power Multiplier.

Categories:

Entry may be All-band, Single-, High-, or Low-band.

Entry includes a copy of logs and summary sheet. Include legible name, call, address, and ARCI number, if any. Entry must be received within 30 days of contest date. Highest power used will determine the power multiplier.

The final decision on all matters concerning the contest rest with the contest manager.

Entries are welcome via e-mail to rfoltz@turbonet.com or by mail to

Randy Foltz
809 Leith St.
Moscow, ID 83843

After the contest send your Claimed Score by visiting http://personal.palouse.net/rfoltz/arci/form.htm. Check the web page for 10 days after the contest to see what others have said and claimed as their score.

2003 Milliwatt Field Day

NOTE: You do NOT have to run less than 1 watt to play in this contest! Usual QRP power levels are just fine. However, because this is a piggy-back contest on ARRL Field Day you need to use their definition of SSB QRP which is 5 W PEP.

Date/Time:
June 28, 2003 1800Z to June 29 2100Z
Modes:
CW, SSB, Digital
Exchange:
Same as for the ARRL contest. See May *QST* issue for exchange details and full rules.
QSO Points:
Same as ARRL rules: Phone counts one point/QSO; CW counts 2 points/QSO; Digital counts 2 points/QSO.
Power Multiplier:
See ARRL rules. Multiplier based on transmitter power and power source.
Bonus Points:
No special QRP ARCI bonus points. ARRL bonus points are not used in ARCI scoring, either.
Score:
Same as ARRL rules, but no bonus points. Total number of QSO points times the power multiplier.
Entry Classes:
One watt or less—one operator
One watt or less—two operators, one transmitter
Five watts max—one operator
Five watts max—two operators, one transmitter
Club class

In short, use the ARRL rules and scoring without the bonus points and send me a summary sheet. Entry must be received within 30 days of the contest date.

The final decision on all matters concerning the piggy-back contest rests with the contest manager.

Entries are welcome via e-mail to rfoltz@turbonet.com or by mail to

Randy Foltz
809 Leith St.
Moscow, ID 83843

After the contest send your Claimed Score by visiting http://personal.palouse.net/rfoltz/arci/form.htm. Check the web page for 10 days after the contest to see what others have said and claimed as their score.

2003 Summer Homebrew Sprint

Date/Time:
July 13, 2003, 2000 Z through 2400 Z. CW only.
Exchange:
Member - RST, State/Province/Country, ARCI number;
Non-member - RST, State/Province/Country, Power out
QSO Points:
Member = 5 points; Non-member, different continent = 4 points; Non-member, same continent = 2 points
Multiplier:
SPC (State/Province/Country) total for all bands. The same station may be worked on more than one band for QSO points and SPC credit.
Power Multiplier:
0 - 250 mW = x15
Greater than 250 mW to 1 W = x10
Greater than 1 W to 5 W = x7
Over 5 W = x1
Bonus Points for Homebrew Gear (per band):
Add 2,000 points for using HB transmitter; add 3,000 for using HB receiver; or add 5,000 for using HB transceiver. If you built it, it is homebrew!
Suggested Frequencies:

160M	1810 kHz
80M	3560 kHz
40M	7040 kHz
20M	14060 kHz
15M	21060 kHz
10M	28060 kHz

Score:
Points (total for all bands) X SPCs (total for all bands) X Power Multiplier + Bonus Points.

Entry may be All-band, Single-, High-, or Low-band. Entry includes a copy of logs and summary sheet. Include legible name, call, address, and ARCI number, if any. Entry must be received within 30 days of contest date. Highest power used will determine the power multiplier.

The final decision on all matters concerning the contest rest with the contest manager.

Entries are welcome via e-mail to rfoltz@turbonet.com or by mail to

Randy Foltz
809 Leith St.
Moscow, ID 83843

After the contest send your Claimed Score by visiting http://personal.palouse.net/rfoltz/arci/form.htm. Check the web page for 10 days after the contest to see what others have said and claimed as their score.

How to Operate the Contest: Summer Homebrew CW Sprint

Date: July 13, 2003 from 2000 Z to 2400 Z

How to participate: Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies of 3560, 7040, 14060, 21060 and 28060 kHz. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself. You can work a station again on a different band.

What to send: Give a signal report and your state (for Americans), province (for Canadians), or country (for everyone else); and QRP ARCI member number if you have one, or your power if you don't have one.

Best reason to participate: You can pickup needed states for 2x QRP WAS in one afternoon.

Relative challenge: Easy for all. (Slower code speeds, short duration, good number of participants, QRP only contest).

Scoring: Standard QRP ARCI method for CW contests

Web link: http://personal.palouse.net/rfoltz/sumhom.htm

A Field Day Checklist

Gary Breed—K9AY k9ay@k9ay.com

Although my recent Field Day operations have been casual, I still vividly remember the years I was Field Day Chairman for the Arapahoe Radio Club, based in Littleton, Colorado.

In the years between 1980 and 1995, the call KØNA was familiar to most FD operators. During those years, the Arapahoe Radio Club had fourteen top scores in their class plus two #2 finishes. I was FD chairman during the last several years of the club's successful reign at the top of the 2A Battery class (and one detour to 3A Battery). When the club disbanded, the trailer, towers, antennas and hardware were passed on to the Colorado QRP Club—which eventually moved their FD operation to our "secret weapon" location in the Pike National Forest. In 2001, the CQC finally broke our 2A Battery record.

They say you learn from your mistakes, and we made enough mistakes to learn a lot! Lots of different rigs and antennas were tried, various battery solutions came and went, we experimented with HF packet, satellite and VHF stations, and had several different Novice/Tech operations.

One year, we even got a Denver television station to send a reporter and cameraman, and got a nice story on the Sunday evening news. That was pretty cool!

Our Most Important Lessons

At the top of our list is this—At Field Day, "winning" takes second place to having fun! There is no substitute for a weekend with people you like, trading real stories, lies and half-truths! As a bonus, our club got to do it at 8200 ft. in the foothills of the Rocky Mountains.

The next lesson is that FD can be successful with many variations in personnel, antennas and equipment. During our successful run of FD "wins," we had anywhere from 6 to 30 participants, with very ambitious antenna installations as well as more modest setups. I think we tried a different antenna for 40M every year.

We became confident that we could deal with emergency communications effectively—Field Day gave us practice setting up a major comm center in a very short time, in the middle of nowhere.

Field Day Suggestions

I've compiled some lists to help plan your club's next Field Day operation. These may not be a perfect match to your club's FD objectives, and they may not be 100% complete, but they should help get you get started in the planning process.

The final lesson we all should learn from Field Day is that good planning makes for good results. It's no fun traveling 50 miles into the countryside, only to realize that something important was forgotten!

Have a great 2003 Field Day!

—73 de K9AY

Field Day Antennas

Antenna selection for Field Day involves many factors, such as location, amount of help, number of stations and operating objectives (casual or competitive). Here are some notes based on my experience with several different FD operations:

160M and 80M—Summertime noise levels make 160M difficult, and it gets little FD activity. However, 80M has lots of activity, especially East of the Mississippi and on the West Coast. In these areas, a dipole or inverted-V is a simple and effective choice. In 2001, I worked plenty of stations with 5W from Northern Wisconsin using a dipole only 15-25 feet off the ground. In areas where there aren't many short-skip stations (like the entire Mountain Time Zone!), a lower angle of radiation is better, so a vertical with plenty of radials may be the best choice. If you have some really tall trees, a high dipole or a delta loop are also good options.

40M—This band and 20M are the "workhorse" bands during FD. At night, 40M is open everywhere across the continent. If you have only one antenna, make it a dipole up 50 feet or higher. In Colorado, we found that a dipole generated the same overall results as a wire beam or Bobtail Curtain—these big antennas were great in their favored directions, but we missed stations off the back and sides. On the other hand, stations in a "corner" of North America (like Southern California or Florida) can benefit greatly from a Yagi, double-Zepp, Vee-beam or other directive antenna.

20M—To deal with lots of QRM and lots of signals, a gain antenna will pay off. You will need to rotate it regularly to follow propagation or cover different areas, but that's the tradeoff for a bigger signal. A small triband Yagi or quad on a 40-foot mast is a practical portable antenna, but if you have the resources, move up to a big tribander or 20M Yagi. Wire antennas like the Field Day Special 2-element wire Yagi are good choices, but you may need two of them to cover most of the US and Canada.

15M and 10M—Propagation changes regularly on these bands, so a beam antenna that can be rotated will give the best results. Wire antennas can be quite effective, since these bands are usually less crowded. However, summertime absorption can reduce signal strength in the middle of the day and make you wish you had a beam.

Many QRPers use random wires and other simple antenna/tuner combinations on the HF bands. Sometimes they are the only practical choice due to size and weight limitations, but if you can add a higher performance antenna to your arsenal on 40M or 20M, it will dramatically increase the number of QSOs.

VHF—Gain is essential, especially at QRP power levels. Fortunately, VHF Yagis are relatively small, which makes them easy to transport, even fully assembled. They only need to be raised above nearby objects, on a short mast or hung from a tree limb.

General Field Day Planning

I. One Month (or More) Before Field Day

- Form a Field Day Committee and assign areas of responsibility—antennas, radios, transportation, generator or batteries, logging/computers, GOTA station, VHF station, publicity, information table, etc.
- Decide on practical matters like food and shelter—what will be done as a club, what will be each participant's personal responsibility. Are water and sanitary facilities available? If not, are portable facilities required?
- Choose the location and make reservations (required for many public parks). Make one or more advance scouting trips to plan station and antenna locations.
- Inspect and inventory any stored FD equipment and hardware. Replace missing items and fix or replace what's broken.
- Send out publicity and invitations to elected officials and public agencies!

II. One Week Out

- Identify any last-minute problems and deal with them before you're on-site.
- Collect all materials to make sure everything is ready—ideally, everyone bringing FD gear should lay out the things he/she is responsible for in the garage or yard. This will quickly identify missing pieces. Wrong or missing cords and cables are usually the biggest on-site problems!
- Make an operating plan—hour-by-hour scheduling is useful for the first 6 or 8 hours, but expect things to change "on the fly" during FD, depending on conditions, activity and available personnel.
- Remind club members about FD via Net, E-mail or telephone.

III. Arrival On Site

- Locate stations, unload equipment, get helpers started with setup—begin with the fundamentals of shelter and power.
- Make contact with local authorities if necessary (e.g. at public locations).

IV. Setup

- This is where planning can pay off in a big way! You should already know where the stations will be set up, where antennas go, etc. If not, be sure to think through each item before committing to its installation.
- SAFETY FIRST! Wear hard hats around towers, tie off guy wires securely, use proper ropes and knots! Put flags or other markers on low ropes and cables. Be especially careful with generator fuel. (Or just use batteries!)
- Remember safety again when climbing trees, using slingshots, compressed air guns or "spud guns" to install antennas. And watch for power lines!!!

V. Operating

- Get everyone involved!
- Use experienced operators to teach the less-experienced, explain what's going on to non-hams, split headphones so others can listen.
- Use the opportunity to explore new modes—try out PSK, build code speed, see how satellites work, etc.
- Make lots of contacts! When activity is high, have a good operator at the key or mic to get a good QSO rate—pileups are a bit intimidating for the less-experienced ops anyway, so give them a chance to watch the pros at work.

VI. Tear Down

- SAFETY FIRST! The crew will be tired and anxious to head home.
- Clean up the equipment and pack it neatly—too much FD equipment gets put away wet or dirty, and kinked coax is a no-no.
- Be good citizens and leave the FD site cleaner than you found it!

Possible Pitfalls

Learn from the mistakes of others! Here are some things that can make your Field Day more of a hassle than necessary.

Dead batteries—QRP battery is a popular operating class, but it's easy to underestimate the number of amp-hours necessary to run all the radios. This is especially true at class 2A and higher, where the club operates a Get On The Air (GOTA) station and VHF station. And, batteries cannot be recharged during Field Day, except with a natural power source like solar cells or water-driven generator.

Untested computer logging—I've sure heard some interesting stories about computer logging at Field Day! I'm amazed at how many operations had no test setup to get the bugs out before FD, and no operator training on the software to be used. Just remember that logging is every bit as important as the rigs and antennas, and you'll be OK.

Lack of basic creature comforts—That high ridge outside of town may be a great radio location, but the lack of water, shelter and sanitary facilities can make Field Day a lot more stressful than necessary. If your club plans such a remote operation, be sure you have some experienced campers and RVers who can help plan this important non-radio part of FD.

Broken equipment—Many clubs have antennas, towers, coax and other equipment that is only used for Field Day. Problems are guaranteed if these things were not packed away carefully after last year's outing. Check over FD equipment *before* you head to the site! Another problem is club members borrowing FD gear for "temporary" personal use over the winter. These loaners need to be tracked down and returned.

Entry not submitted—Believe it or not, a surprising number of major Field Day efforts have missed the deadline for submitting their entries to the ARRL! Usually, everyone thinks someone else is taking care of it. Don't let this kind of communication failure keep your club from getting its results into *QST*!

Renew Now!
Beat the July 1, 2003 Dues and Subscription increase!

Beginning July 1, 2003, new and renewal membership in QRP Amateur Radio Club International (including your subscription to QRP Quarterly) will increase to $18 for US members, US$21 for Canadian members, and $US23 for all other parts of the world.

This increase, the first in a long time, reflects the increased cost of club operations and for producing and mailing the official journal of the club, QRP Quarterly.

QRP ARCI continues to grow, reflecting the fact that QRP operating and homebrewing is one of the most active parts of ham radio! Member serial numbers will soon reach the 12,000 mark.

Keeping up with this growth, QRP Quarterly has become the best hands-on technical journal in our hobby. The projects, operating tips, contests and local club activities described in the pages of QQ are indispensible for an active QRPer.

THE GOOD NEWS: Until July 1, all renewals and memberships will be at the old rates. And you can get an even better deal—a 2-year membership at the old rate. This lets you save nearly 17% off the new rates!

Photocopy the form below and send it with your check or money order to the QRP ARCI address below. Or, go online to www.qrparci.org and use PayPal to make a credit card payment.

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PayPal replaces all previous methods of payments for non-US hams, except that you may always send your payment directly to the club Treasurer, however, ***Funds must be drawn on a U.S. bank and be in U.S. dollars.*** Make checks out to: **QRP ARCI**.

If you pay by check or money order, photocopy the subscription form at the left, fill it out and send it to the address below. When renewing, it helps to send in the mailing label from your *QRP Quarterly*. Send applications by mail to:

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Effective with the Summer 2003 issue, advertising rates and policies are:

- **Basic Rate (black & white):** $400 per page for one issue. This amount is prorated for each fraction of a page, e.g. $100 for a 1/4 page ad or $50 for a 1/8 page ad.
- **Basic Rate (color):** $500 per page for one issue. Color ads are available on the inside front cover (Cover 2), inside back cover (Cover 3) and the back cover (Cover 4). The minimum charge for any color advertising is $125, equivalent to a 1/4-page ad.
- These basic rates may be discounted for multiple advertisements. We encourage continuous advertising contracts of one year (four issues) or longer.
- The management of QRP ARCI and Summit Technical Media reserve the right to reject any advertisement deemed objectionable or inappropriate.
- Advertising rates and policies are subject to change.

Ad materials: Digital files. Contact the advertising representative for acceptable formats. We can also help create ads from your ideas and photos.

Contact: Gary Breed
Summit Technical Media, LLC
6666 Odana Road, #508
Madison, WI 53719
Tel: 608-845-3965
Fax: 608-845-3976
E-mail: gary@highfrequencyelectronics.com

Advertising in *QQ* doesn't cost — it pays!

QRP Quartely, the official journal of the QRP Amateur Club International (QRP ARCI), is published four times each year by Summit Technical Media, LLC, under contract to QRP ARCI and sent to all current members worldwide. Membership dues are $15 (US members), US$18 (Canada), US$20 (all other countries). Effective July 1, 2003, dues will be increased to $18 (US members), US$21 (Canada), US$23 (all other countries). Dues include $15 (US), $18 (Canada), $21 (elsewhere) for a *QRP Quarterly* subscription.

New subscriptions, renewals and address changes should be sent to: QRP ARCI, 117 E. Philip St., Des Moines, IA 50315-4114, or online at: www.qrparci.org

Summit Technical Media, LLC can reached at: Business Office, 7 Colby Court, Suite 4-436, Bedford, NH 03110, tel: 603-471-0716, fax: 603-471-0716; Editorial and Production Office, 6666 Odana Road, #508, Madison, WI 53719, tel: 608-845-3965; fax: 608-845-3976.

The QRP-ARCI Toy Store

The **official** QRP-ARCI Coffee Mug. Used by the top QRP Fox hunters, contesters and casual operators found near the normal QRP Frequencies. Kelly Green on White and the Logo is on both sides. Coffee, tea or milk not included.

The blue and brass metal pins have a tie-tac pin and clasp on the back.

The White '72' pins say "WISHING YOU 72 GOOD QRP"

Midnight Blue mugs are still available.

The QRP-ARCI patches are fully stitched, black on white. 3-9/16" wide x 2-1/2" high oval. And they can either be ironed on, or sewn on the finest evening wear!

Trouble reading those resistors? Plastic magnifiers for kit builders in a carrying case. Magnifiers are $1.00 each.

All Prices PostPaid!

Patches $5 Coffee Mugs $8 Blue Pins $7

2002 Dayton FDIM Proceedings...	$17
2001 Dayton FDIM Proceedings...	$17
2000 Dayton FDIM Proceedings...	$16
1999 Dayton FDIM Proceedings...	$16
1998 Dayton FDIM Proceedings...	$16
1997 Dayton FDIM Proceedings...	$16
1996 Dayton FDIM Proceedings...	$16
Any 4 or more FDIM Proceedings...	$13 each

Antennas & Feedlines for QRP by L.B. Cebik... $16
The North Georgia QRP Club Compendium, Vol. 1... $16

No shipping & handling on pins & patches when ordered with a coffee mug!

QRP-ARCI Hats

Denim Blue Tan Charcoal Tan/Blue Tan/Green Green

Hats are $15 each postpaid

Orders to:

QRP-ARCI Toy Store
2130 Harrington Road
Attica, MI 48412-9312
Checks made out to: QRP-ARCI
or PayPal to k8dd@arrl.net

Going to Dayton? **QRP ARCI's Four Days in May (FDIM) Presents:**

VENDOR NIGHT
Friday, May 16, 2003
7:30 to 11:30 p.m.
Ramada Inn South
Dayton, Ohio

• Vendors or QRP clubs wishing to have a table should contact Bill Phillips, AD6JV (bill1048@direcway.com) •